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"S.V.H."		"LLOYDS"		"S & L"		"H.M."	
Silicon	1·25 to 4·0%	Silicon	2·0 to 5·0%	Silicon	2·0 to 4·5%	Silicon	2·0 to 4·5%
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Phosphorus	·6 to 1·0%	Phosphorus	1·6% approx.	Phosphorus	1·0 to 1·2%	Phosphorus	1·0 to 1·2%
Manganese	·6 to 1·0%	Manganese	·35%	Manganese	·4 to ·8%	Manganese	1·0 to 2·0%
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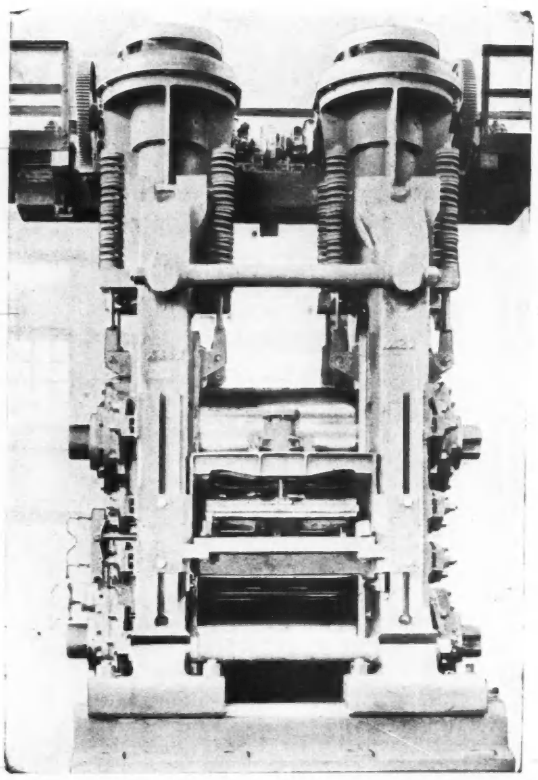

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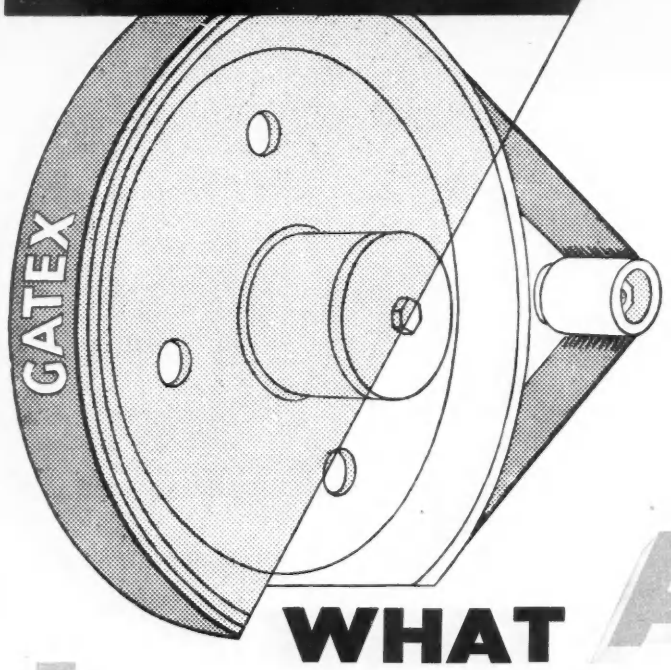

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A Seven-Day Journal

A Clyde Shipping Deal.

ARRANGEMENTS have now been completed for the purchase of the Clyde shipping business of John Williamson and Co., Glasgow, by the London, Midland and Scottish Railway Company in association with David MacBrayne (1928), Ltd. We are given to understand that the transfer will take place at the end of the present month, when the Firth of Clyde tourist services close. By the acquisition of the Williamson fleet of seven turbine and paddle steamers the position of the L.M.S.-MacBrayne interests on the Clyde will be greatly strengthened. There are already about fourteen L.M.S. passenger vessels in the Clyde existing services, and Messrs. MacBrayne own a further twenty ships, which are mainly employed in the Western Isles services, only a few being used on the Firth of Clyde. The firm of John Williamson and Co. is the managing owner of two companies, one of which is Turbine Steamers, Ltd., and the other Williamson Buchanan Steamers, Ltd. The vessels of the former fleet include the turbine steamers "King George V," and "Queen Alexandra," while those of the latter fleet include the turbine steamers "Queen Mary II," and "King Edward," and the paddle steamers "Eagle III," "Kylemore," and "Queen Empress." The Williamson business was formerly a family concern, which for two generations was closely associated with the steamboat services on the Clyde. Mr. John Williamson, who died in 1923, in association with Sir Charles Parsons and the Denny Brothers, sponsored the "King Edward," the first commercial turbine ship, while Captain James Williamson's book of 1904 on "The Clyde Passenger Steamer," tells the story of the development of these steamers from the "Comet" of 1812 to the "King Edward" of 1901.

A New Netherlands Waterway.

ON Monday, September 16th, her Majesty the Queen of Holland, in the presence of Princess Juliana and a large gathering of engineers and representatives of public authorities, formally opened the Princess Juliana Canal, which has been constructed in the south of Holland. The northern part of this canal was, it may be recalled, opened last year, and the finishing of the southern part, just opened, completes the canalisation of the Maas on Netherlands territory. The new canal runs in almost a straight line from the north of Maastricht to Maasbract, and will place the coal mines of Southern Limburg in direct touch with other parts of Holland. The work was begun almost twenty years ago, and a total sum of about £11,000,000 has been spent on it. The canal has a length of nearly 20 miles with a width of 52ft. and a depth of 16ft., and ships up to 2000 tons can use it. There are four large locks, and the difference in water level between the two ends of the canal is about 74ft. The canal is crossed by no less than eleven bridges, all of which are constructed so as to leave a clearance of at least 23ft. above the surface of the water.

A Trans-Continental High Road.

AT the International Touring Conference, which ended on Saturday, September 14th, at Budapest, resolutions were passed suggesting that the width of the proposed transcontinental high road from Calais to the Black Sea should be fixed at 9 m. The proposed road is planned to start from Calais, where it would connect with the ferry service from Dover. It would run by way of Ostend and Brussels through Belgium, through Germany by way of Cologne, Frankfurt, and Nuremburg, and thence on to Vienna and Budapest. At this point it would fork, the northern branch cutting across Rumania to Bucharest and Constanta, with a southern branch to Sofia and Constantinople. It was decided that separate bicycle and pedestrian paths should be made near towns, and that a future widening by 2 m. should be taken into account. Other resolutions dealt with the marking of the road by signs and the marking of dangerous spots, curves, and railway crossings, by light signals or warning horns. A permanent committee has been set up which will meet in Budapest in order to deal with the actual problems of the proposed highway. It will consist of eighteen members, two being nominated by each of the States interested in the scheme.

Yorkshire Pit Disaster.

ON the night of September 12th an explosion, followed by a fire, occurred at the North Gawber Colliery, Barnsley, in Nos. 3 and 4 workings. The death roll was seventeen men, one of whom succumbed to his injuries in hospital, the remainder being killed in the explosion. Seven men were injured, and of these the condition of five is reported to be critical. At the time of the accident 160 men were at work underground, and we understand that all have now been accounted for. The workings where the disaster occurred are 450ft. deep. The fire was described as extending over a length of about 200 yards of the workings. Considerable anxiety was felt at the pit-head when, for some time, the flames prevented the rescuers from reaching the trapped men. The pit, which is the property of Fountain and Burnley, Ltd., of Barnsley, was inspected on the following day by Major H. J. Humphreys, of Doncaster, the Divisional Inspector of Mines, and by other officials, including Mr. R. Parkinson, superintendent of Barnsley Rescue Stations. The Secretary for Mines is directing Sir Henry Walker, Chief Inspector of Mines, to hold a formal investigation into the accident. According to an official statement issued on Saturday the fire was completely out within two hours of the accident, and the site had been traversed by officials.

Grid Supply for Port Sunlight.

AFTER negotiations extending over a long period, agreement has been reached between the Central Electricity Board, the Birkenhead Corporation, and Lever Brothers for a supply of electricity from the grid to meet the needs of Port Sunlight. The original private generating station is to be associated with the grid and under the direction of the Central Electricity Board is to be operated in conjunction with the station belonging to the Birkenhead Corporation. Port Sunlight was planned as the centre of Lever Brothers' soap-manufacturing business, but it has since been developed to cover many allied products, and other industrial firms have been attracted to the estate, which now covers an area of about 2000 acres, with a population of approximately 20,000 people. The Port Sunlight power station was built to meet all requirements, which amount at the present time to a load of nearly 40,000,000 units per annum. It is expected that in ten years' time the demand will be doubled, and the Central Electricity Board has therefore acquired a valuable asset. Other important industrial concerns that have changed over to public supply within recent times are the steel works of Stewarts and Lloyds, at Corby; the steel works of Brown-Firth, at Sheffield, and the thread mills of J. and P. Coats, at Paisley.

British Shipping and Foreign Competition.

IN the course of a speech made on the new P. and O. liner "Strathmore," on Friday evening last, before she left Liverpool for her Clyde trials, the Hon. Alexander Shaw, the chairman of the company, drew attention to the immediate necessity for the defence of British shipping against State-aided foreign competition. He said that unless some action was taken at once he feared it would be necessary to withdraw the British passenger and mail service on the line between New Zealand, Australia, and San Francisco within the next few months. Much the same condition, he pointed out, was to be seen in the important British shipping link of Empire between Canada on one side of the Pacific Ocean and Australia and New Zealand on the other. In these circumstances the building of new passenger and mail vessels in Great Britain was rendered impossible. Since Mr. Shaw's speech Mr. Lyons, the Prime Minister of Australia, has stated that arrangements are already completed for a conference in London before the end of this year, which, it is hoped, will secure a more equitable distribution of the Pacific traffic and will result in orders being placed for ships in this country. At that conference Australia, it has been stated, will be represented by Mr. S. M. Bruce, the Commonwealth's High Commissioner in London, and New Zealand by Sir James Parr, New Zealand's High Commissioner, while representatives of British and American shipping interests will also attend. Mr. Lyons emphasises the fact that while the shipping services to Tasmania were subsidised in order to improve the mail service, the Commonwealth Government is opposed to subsidising British shipping operating outside Australian waters. The object of the conference would be to enable the British and American shipping companies to try to reach an amicable settlement, reserving a fair proportion of shipping to the British companies.

The Late Lord Kirkley.

BY the death of Lord Kirkley, which took place at his home, Kirkley Hall, Ponteland, Northumberland, on Wednesday of last week, September 11th, the North of England has lost one of its great men. Lord Kirkley, who was seventy-two, was the son of the late Mr. John Noble, and was all his life closely connected with shipping. He was articled at the age of fourteen to Messrs. Stephens, Kendrick and Mawson, and later served with Messrs. Chapman and Miller. At the age of twenty-five he went into partnership with the late Mr. Thomas Cairns and in 1892 the Cairn Line of steamships was formed. Mr. Noble, as he then was, was the first shipowner to introduce the Parsons geared turbine into purely cargo vessels. In 1908 the Thomson Line was absorbed and the Cairn Line quickly became a leading shipping undertaking. In 1920 he was President of the Chamber of Shipping and for many years he held the presidency of the Baltic and White Sea Conference. Some of his greatest work was accomplished for the Tyne Improvement Commission, of which he was Chairman for five years up to November, 1930, and then became a life member. His work for Tyneside and his country was recognised by the Government and he received a baronetcy in 1921 and was raised to the peerage in 1930. In that year he became Chairman of the Economic Mission appointed by the Government to investigate trade possibilities in South Africa, and on his return he made strong recommendations to manufacturers to meet the needs of the South African market. Although not an engineer, he was closely associated with marine engineering development and was in 1921 elected President of the North-East Coast Institution of Engineers and Shipbuilders.

Board of Trade Returns, 1935.

FIGURES given in the Board of Trade returns issued on Saturday last for the eight months January to August, 1935, give the value of imports to this country at £479,091,872, a decline of £301,166 on the corresponding period of 1934. Exports are given at £277,736,951, an increase of £22,647,627. The figures for the month of August, 1935, are given as £59,145,107 imports and £34,882,955 exports, compared with £59,970,693 imports in August, 1934, and £32,090,009 exports in the same period. For July, 1935, the imports are given as £61,824,608 and the exports as £36,443,449. The figures given for the heavy industries show their participation in the improvement in British trade over August last year. They are:—Export of non-ferrous metals and manufactures thereof, £1,173,868, an increase of £395,551; export of iron and steel and manufactures thereof, £3,166,199, an increase of £271,857; machinery, £2,939,977, an increase of £349,827; and vehicles, including locomotives, ships, and aircraft, £2,292,653, an increase of £596,776. This month the export of coal has risen generally by £203,682 on August, 1934, though there has been a reduction in coal sent to Italy, which has fallen by £38,432. Exports of machinery are up by £349,827 over last year's figure for August, the principal increases being to South Africa, £115,828; to Irish Free State, £26,743; to British India, £59,896; to Australia, £55,740; and to New Zealand, £50,911. In the category of non-ferrous metals the two largest rises in British exports are £343,500 total to the United States, compared with £14,598 in August, 1934, and £87,965 to Germany, compared with £21,125 a year ago.

The Exeter By-pass Road.

THE announcement is made that a grant from the Road Fund is to be made to the Devon County Council for the completion of the Exeter by-pass road. Two-thirds of the road, which will be nearly five miles in length, are already completed, and work is to be begun at once on the remaining section with a view to its completion by the end of next year. The proposed section will follow the line of the existing road to Countess Wear Bridge, which will be widened from 13ft. 7in. to 45ft. in order to carry a 30ft. carriageway and two footpaths. Special care is to be taken to retain the picturesque features of this bridge, which is scheduled as an ancient monument. The new road will then cross the Exeter Canal by an electrically operated swing bridge, and will then continue in a south-westerly direction to the Great Western main line, where the existing bridge will be widened from 19ft. 6in. to 50ft., in order to conform to the reconstructed approaches on either side of it. The new by-pass road will then join the Exeter-Dawlish road, and will swing westward along that road to Matford House, at which point it will branch off to join the Plymouth road, just north of Peamore House. The cost of this last section is estimated at about £110,000, which will bring the total cost of the new by-pass to over £200,000.

Pollution of the Sea by Oil.

THE League of Nations has just published, through its agents, George Allen and Unwin, Ltd., London (price 1s. 3d.), a summary of the replies received by the Organisation for Communications and Transport to a questionnaire circulated to member countries of the League in January this year, on the question of the prevention of the pollution of the sea by oil. We note that, while damage to birds is admitted, the principal countries are mostly opposed to the compulsory fitting of oil separators in existing ships in view of the heavy financial burden which such a course would place on the shipping industry, especially in its present difficult position. The hope is, however, expressed in some replies that an international convention on the problem of the pollution of the sea by oil will eventually be held. We may recall the fact that it was the British Government which raised this question with the Secretary-General of the League of Nations in July last year, and it is of interest to record that the questionnaire which was circulated to the various countries was accompanied by lists of British separators designed for use on ships and separating barges and shore plant available for use in British naval and commercial ports.

Electric Driving.

No. V.

(*Continued from page 259, September 13th.*)

WHEN speeds below those for which motors can be conveniently and economically built are required, geared motors are now frequently utilised. High-speed motors are cheaper, more efficient, and occupy less space than slow-speed machines. Induction motors working on a 50-cycle supply can be conveniently wound for speeds of about 1440 or 950 r.p.m., and it is necessary in the majority of cases to introduce between the driving and driven shafts some form of speed reducing equipment, such as belts and pulleys or toothed gear wheels, which are common objects in workshops. Back-geared motors have their field of application. In some cases a separate gear-box with a train of gears running in oil is employed between the driving and driven shafts, but by incorporating the gear-box in the motor a relatively cheap and compact unit is produced. The geared motor is a substitute for a separate motor and gear coupled together and mounted on a common bed-plate.

Single and double reduction "Handigear" units for A.C. or D.C. are made by Lancashire Dynamo and Crypto, Ltd., of Trafford Park, Manchester, for outputs of ¼ to 1 h.p. and single, double, and triple reduction Crypto-Langham units up to 15 h.p. Another range with single and double reductions covers outputs of 20 to 75 h.p. "Handigear" units are particularly suitable for pumps, conveyors, small machine tool drives, brewery and dairy machinery, &c. All the motors, both A.C. and D.C., in this range are wound to run at 1425 r.p.m. Standard shaft speeds for the single reduction "Handigear" units are 496, 454, 414, 394, 388, 302, and 285 r.p.m., and for the double reduction units 258, 236, 218, 198, 182, 167, 159, 152, 146, 124, 107, 95, 82, 77, and 69 r.p.m. All these units are equipped with ball and roller bearings throughout. On the range of Crypto-Langham units made for outputs up to 15 h.p. the speed range on the single reduction equipments may be 5 to 1, on the double reduction machines 20 to 1, and on the triple reduction 100 to 1, a final speed of 9 r.p.m. being permissible. All geared units can be arranged for direct coupling or with an extended shaft and outboard bearing and base-plate for pulley, chain, or pinion drive. Any final shaft speed between 500 and 50 r.p.m. can be obtained in the range covering single and double units with outputs ranging from 20 to 75 h.p.

Apart from the fact that the motors may be A.C. or D.C., they may have any type of enclosure, such as the protected, totally enclosed, or gasworks type of enclosure. The gear-box allows the motor complete with its pinion to be withdrawn by merely removing four nuts securing the gear case cap. Examples of the use of these geared units are illustrated in Figs. 42–45. The first shows two Crypto-Langham motor units driving a tin-plate mill. The main unit is a 30 h.p. slip-ring motor running at 710 r.p.m. and drives the mill through its gearing at 49 r.p.m. For inching the rolls there is a second motor rated at 6 h.p. and driven through a dog clutch. The speed of this auxiliary machine is 700 r.p.m., which is reduced to 29·5 and, of course, still further by the main unit reduction gears. Originally the mill was driven by water, which has now given place to the simple drive shown. The geared Crypto-Langham motors illustrated in Fig. 43 are driving oxygen compressors and it will be perceived that the arrangement is both neat and compact. Each motor is rated at 25 h.p. at 1440 r.p.m., reduced to 350 r.p.m. by the combined gearing. A Lancashire flame-proof motor driving a troughed belt conveyor is shown in Fig. 44, where, it will be noted, the motor and gears are mounted at the side of the conveyor. The motor is rated at 5 h.p. at 960 r.p.m. and the 24in. belt is capable of running at 150ft. per minute when handling 66 tons of coal per hour, or 200ft. per minute when handling 200 tons. An example of the use of a "Handigear" unit is illustrated in Fig. 45, where a ½ h.p. with a final shaft speed of 69 r.p.m. is to be seen driving a leather measuring machine made by the Turner Tanning Machinery Company, Ltd. The actual shaft speed of the motor is 1425 r.p.m.

Single and double reduction spur and helical gear units suitable for any make of flange-mounted motor are made by the Moss Gear Company, Ltd., Birmingham. In both cases the input speeds may vary from 1500 r.p.m. to 720 r.p.m. Standard ratios in the case of single reducing gears cover from 1 to 1 to 5/1 and from 6/1 down to 22 to 1 on double reduction units. Widely spaced roller bearings of large capacity make these gear units capable of carrying large overhung loads on the output shaft and accurate gear cutting and anti-friction bearings are claimed to ensure an efficiency of 98 per cent. While the power that can be transmitted by the single reduction units is from 1 to 20 h.p. that which can be dealt with by the double reduction units is 1 to 15 h.p. Worm gear units are made for transmitting from 1 to 15 h.p. Like the spur gear units, they are suitable for any make of flange-mounted motor with input speed from 1500 to 720 r.p.m. Standard ratios cover a range from 7·6 to 1 to 50 to 1. The unit shown in Fig. 46 is a two-speed spur gear unit with a maximum ratio of 3 to 1, and as it is used in conjunction with a two-speed motor, four speeds are secured. There is, of course, also a neutral position. A single ratio geared unit and motor are shown in Fig. 47 and a worm gear unit with a vertical motor in Fig. 48.

Double and triple reduction geared motors giving final speeds of 480 down to 26 r.p.m. are made by the Normand Electrical Company, of North Side, Clapham Common, S.W.4. The motors, which may be D.C. or A.C. (single, two, or three-phase), develop ¼, ½, ¾, and 1 h.p. and run at 1400 r.p.m. One of the most interesting and useful machines built by the Normand Electrical Company is the Telemotor, giving speeds down to 0·356 r.p.m. It has been

FIG. 42—GEARED MOTOR UNITS IN TIN PLATE MILL

FIG. 43—GEARED DRIVE TO OXYGEN COMPRESSORS

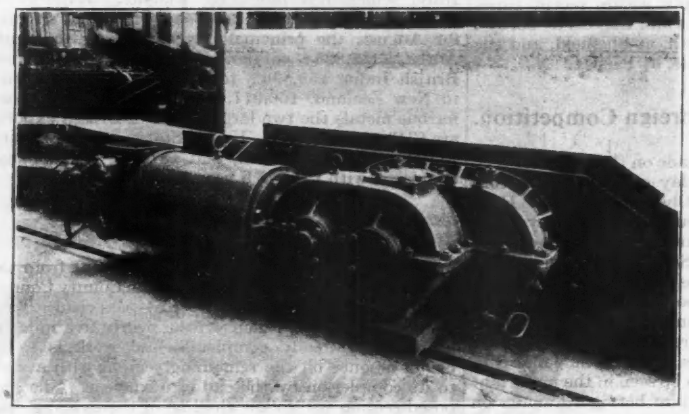


FIG. 44—FLAME-PROOF MOTOR DRIVING CONVEYOR

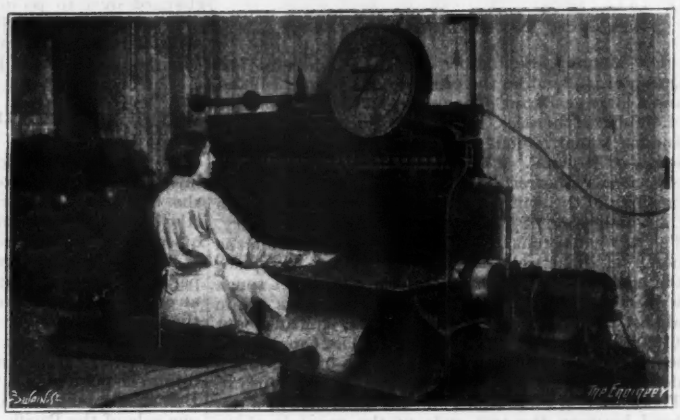


FIG. 45—"HANDIGEAR" UNIT DRIVING LEATHER MEASURING MACHINE

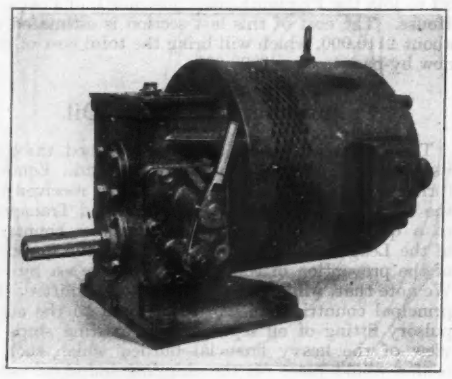


FIG. 46—TWO-SPEED GEARED MOTOR

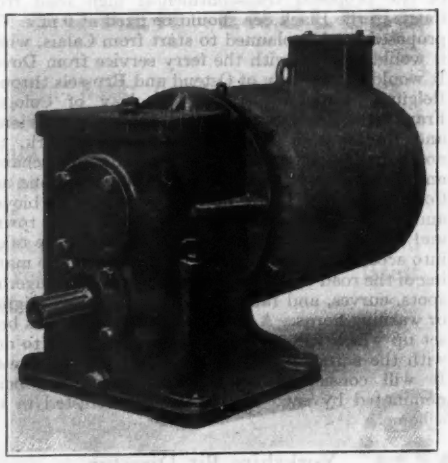


FIG. 47—SINGLE SPEED GEARED MOTOR

introduced to meet the demand for motors capable of exerting considerable torque at very low speeds. It is suitable for operating large ventilating dampers, valves and sluice gates, and very low-speed conveyors. The motor is spigot mounted on a triple

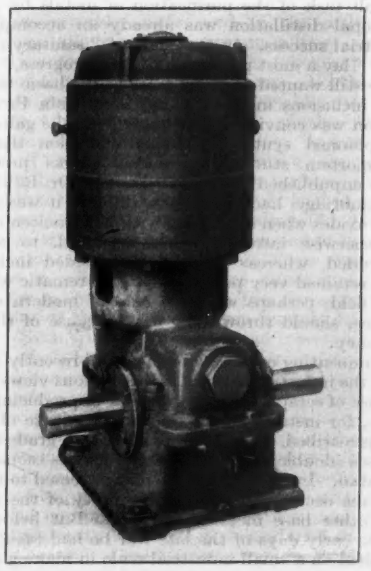


FIG. 48—WORM GEAR UNIT

reduction spur gear-box. The gears run in an oil bath on ball bearings. While the arrangement is similar to that of the standard geared motor, a lower speed motor is used and special gears give the primary reduction to some convenient speed below 20 r.p.m. The motor and gear-box, forming a complete unit, are mounted on a cast iron pedestal and the gear-box final shaft carries an external spur pinion meshing with a large cast iron gear wheel mounted on a shaft running in ball bearings and passing through the pedestal. No couplings are used and the floor dimensions of the pedestal which replaces the usual bedplate are only 12in. by 12½in. By undoing four nuts the motor can be removed from its spigot and when it is replaced the gears are automatically meshed and aligned with the motor pinion. The drive can be taken from the final low-speed shaft in various ways. On damper telemotors the drive is generally through a connecting-rod or link motion, a crank pin being fitted to the large external gear wheel at a radius of 4¾in. For other drives the final shaft can be extended either through the gear or at the back of the pedestal or at both ends. When it is necessary to stop the motor automatically after a fraction of a revolution of the final shaft, limit switches can be mounted on the sides of the pedestal and operated by strikers fitted on the final gear. The switchgear can be arranged to reverse the motor at each succeeding operation, but if more than one complete revolution of the low-speed shaft be needed it is generally better to mount the limit switches on the driven apparatus.

Telemotor Speeds.

Final r.p.m.	Ratio.	Motor r.p.m.
0·36	1948	700
0·48	1948	960
0·70	1948	1400
0·86	816	700
1·2	816	960
1·7	816	1400
1·94	495	960
2·22	432	960
2·82	495	1400
3·0	324	960
3·8	252	960
4·3	324	1400
4·85	289·8	1400
5·56	252	1400

It is then frequently possible to use a gate type limit switch instead of the more costly screw type, which is necessary for motor mounting. After switching off the motor the overrun of the low-speed shaft can generally be neglected, as owing to the very large gear ratio it is very small, but if it is necessary to stop the shaft at a predetermined point a magnetic brake can be fitted. Normally telemotors are supplied with gears capable of transmitting torques up to 100 pounds-feet, but they can be provided with a slightly larger final shaft and stronger gears to transmit torques up to 200 pounds-feet without increasing the overall dimensions. The final speeds available are given in the table above.

Speeds of 0·36 and 0·86 are only obtainable with D.C. and three-phase supplies, but the remaining speeds can be also secured with single-phase current. The speeds of A.C. motors are based on the standard periodicity of 50 cycles. For lower speeds than those given in the table, spur gearing becomes unwieldy, and if really low speeds, such as a few revolutions per hour are needed, it is better to use either a normal motor or a geared motor coupled to worm reduction gear.

The "Enemse" geared motor made by the Northern Manufacturing Company, of Gainsborough, was described in THE ENGINEER of August 24th, 1934. It is made as a fractional horse-power machine

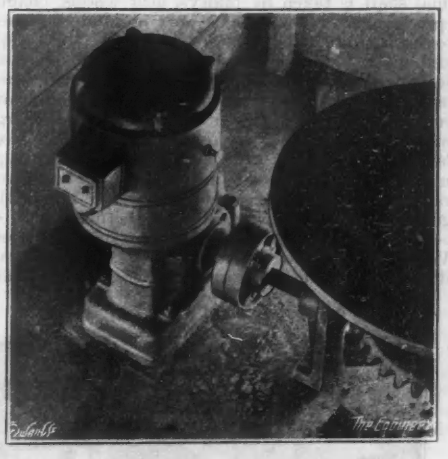
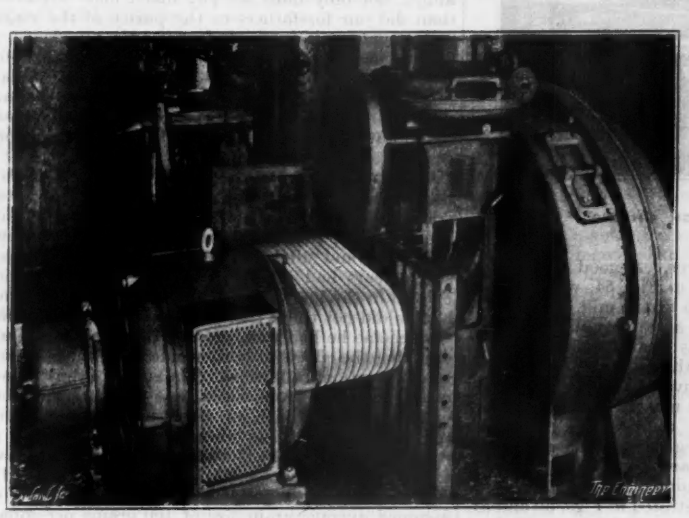
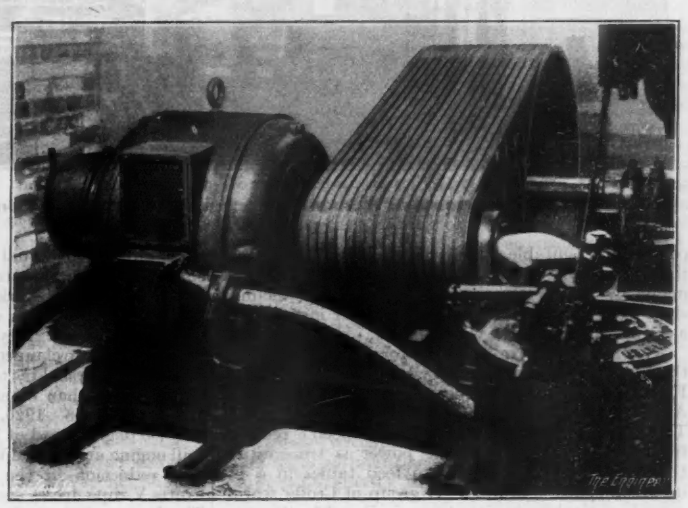


FIG. 53—WORM GEAR UNIT

and for higher outputs. Beyond a slight increase in length this combined unit does not appreciably differ in appearance from an ordinary motor, and owing to the extension of the feet it has adequate rigidity. By extending the end shield at the shaft end to form a casing for the gears and fitting it with a cover identical to that at the other end, a very neat unit has been obtained. Single-phase motors may be of the repulsion start induction type, to be described later. Series parallel connections enable two separate voltages to be covered by one winding. Alternatively, a split-phase, induction-type motor, which also remains to be described, may be supplied. Three-phase motors are squirrel-cage machines, which, like the single-phase motors, are dripproof and fan-ventilated.

Geared motors are supplied by Crofts (Engineers), Ltd., of Bradford, for powers ranging from frac-





FIGS. 50 AND 51—"V" ROPE DRIVES

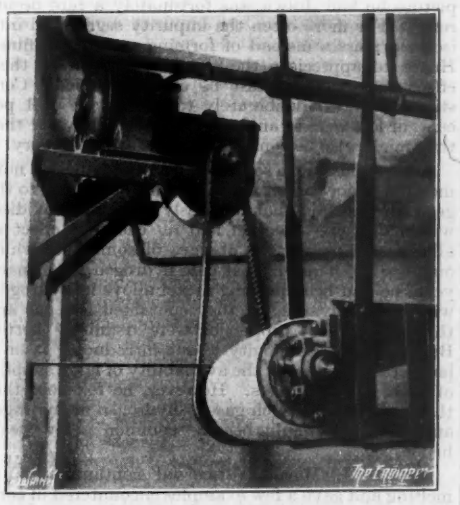


FIG. 49—WORM-GEARED MOTOR DRIVE TO CONVEYOR

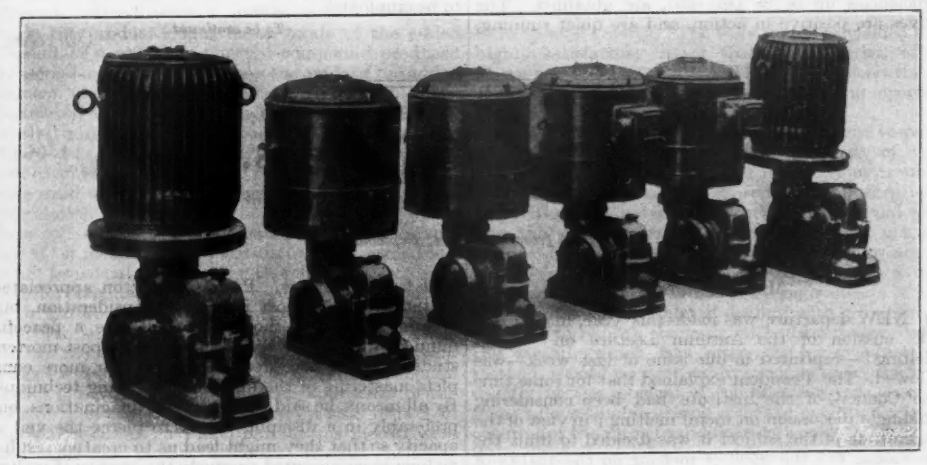


FIG. 52—GROUP OF WORM-GEARED MOTORS

tional powers up to 40 h.p. with standard ratios up to 83 to 1. The efficiencies claimed for single, double, and triple-reductions are 98, 96, and 94 per cent. respectively. Standard-type geared units incorporate flange motors without feet. Heavy-duty motor units are designed to take the stresses imposed by overhung loads, thus eliminating outboard bearings. They are employed generally when the drive from the final shaft is taken by pulleys, gear wheels, chains, sprockets, &c. Universal geared units are designed to incorporate flange motors with feet. Any type and make of motor can be utilised with universal series geared units, which are recommended when larger motors than are normally employed are required, and they are essential for exceptionally large motors, such as totally enclosed machines, which have larger dimensions for a given output than open-type machines. As the gear units can readily be moved radially into any position on the motor flange, the geared motor can be mounted on the floor, wall, or ceiling without alteration to the motor or gear section. Vertical type units are naturally for vertical shaft drives, such as those of stirrers, mixers, &c. They are particularly suitable when it is required to support the drive above a tank. Another geared motor unit made by Crofts (Engineers), Ltd., is an inclined shaft unit designed for tank and similar installations as an alternative to the vertical type.

A Crofts 2 h.p. worm-geared motor driving a conveyor through an inverted tooth-type chain is shown in Fig. 49. The speed reduction is 1430–71·5 r.p.m. A Crofts vertical worm-geared unit is shown in Fig. 53. The motor is rated at 1½ h.p., and the speed is reduced from 960 to 24 r.p.m. The power is transmitted through a flexible coupling to feed tables in a pit in which space is limited. A group of Crofts worm-geared vertical motors is shown in Fig. 52. The two ribbed motors are rated at 9 h.p., and the gear gives a speed reduction of 1460–100 r.p.m., whilst the motors with plain casings are rated at 5½ h.p. and the gear reduces the motor speed from 1430–100 r.p.m.

During the last few years V-rope drives have come into prominence. They are employed for driving many classes of machinery as well as shafting. Efficiencies up to 98 per cent. are obtained. The drives are positive in action, and are quiet running, whilst the resiliency of the ropes protects machinery from shocks. Guards, dust and oil-protecting devices are unnecessary, and maintenance is claimed to be practically negligible. The drives are particularly suitable for high-speed impact machinery, such as coal pulverisers and grinders of every description. Simplicity is another claim made for this type of drive, which consists of a number of endless ropes with two V-grooved pulleys, or, in the case of a "V flat drive," one V-grooved driving pulley and a flat face driven pulley. In the event of one or more of the ropes failing under normal conditions, the remaining ropes are generally capable of carrying the load.

The outstanding advantages of chain drives are that they give very positive transmission, have high efficiency, and a long life. At low speeds chain drives are more efficient than V-rope drives, but at higher speeds the efficiency of the two types is comparable. For large powers at slow speeds the chain drive is generally more compact than the V-rope drive, as duplex or triplex chains can be used with very little increase in space occupied. The size of the driving and driver chain sprockets is usually less than that of V pulleys for equal power. A good example of chain driving is illustrated in Fig. 54, which shows Brook motors in a Yorkshire textile mill. The motor shafts project at both ends and drive on to the line shafting through Reynolds chains. Incidentally, these motors are claimed by the makers, Brook Motors Ltd., Huddersfield, to give a better electrical performance than standard motors conforming with B.S.S. No. 168—1926, the temperature rise being only 60 deg. instead of 72 deg. They have replaced a mill engine and are said to have resulted in a considerable reduction in the running cost. Examples of Crofts V-rope drives are illustrated in Figs. 50 and 51. The former shows a 60 h.p. motor driving a Herbert pulveriser through "Sure Grip V-ropes" at 19¼in. centres, whilst Fig. 51 shows a 150 h.p. motor driving a pumping plant at a textile mill. The ratio is 975–250 r.p.m. From the driven pulley the power is transmitted through a Crofts detachable slide-rim friction clutch coupling to the pump shaft, so that when required the motor can be disconnected from the pump to enable an alternative drive from a line shaft to be employed.

(To be continued.)

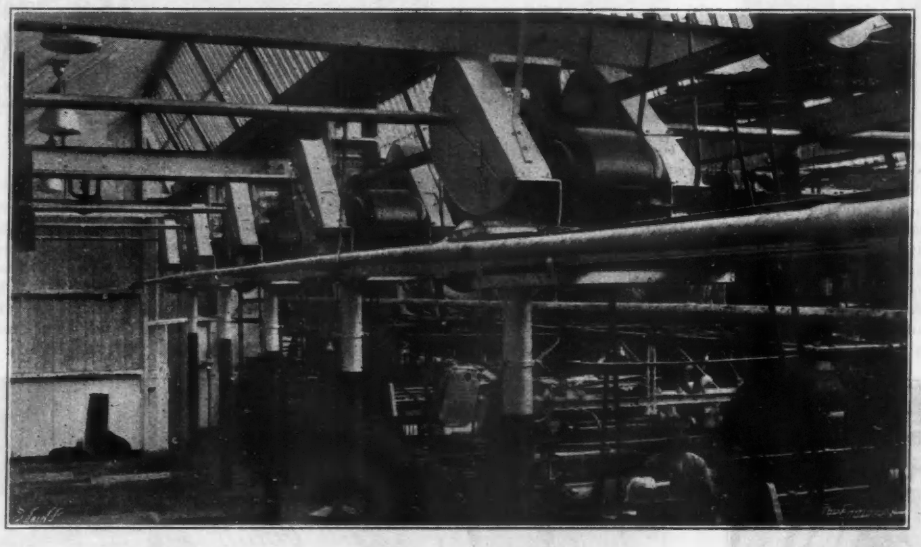


FIG. 54—MOTORS IN YORKSHIRE TEXTILE MILL DRIVING THROUGH CHAINS

Institute of Metals.

No. II.

(Continued from page 274, September 13th.)

METAL MELTING.

A NEW departure was made this year, in that discussion of the Autumn Lecture on "Metal Melting"—reprinted in our issue of last week—was allowed. The President explained that for some time the Council of the Institute had been considering holding a discussion on metal melting; in view of the magnitude of the subject it was decided to limit the discussion to—the effect of melting on the quality of the product.

Professor R. S. Hutton (Cambridge), opening the discussion, first drew attention to Mr. Brownsdon's remark that the fact that metals were opaque drew an impenetrable veil over what was happening in the melting pot; that perhaps it was well for our peace of mind that it should be so; and that all we could do was to let our imagination run riot and draw conclusions from the post-mortem examinations on the cold frozen castings. Professor Hutton appreciated that that was a most important consideration, but he urged that we should not cultivate a peaceful mind or limit ourselves to clinical and post-mortem studies, which had greatly retarded our more complete mastering of the ideal metal melting technique. By all means, he said, let us use our imaginations, but preferably in a disciplined way to pierce the veil of opacity so that they might lead us to creative results. So long as we accepted passively the opacity of molten metal we should be satisfied to skim the surface and pour it with all its internal filth into our ingot moulds. Let us put into practice forthwith obvious methods, such as filtration and the purification of molten metals by shaking them up with solvent fluxes, as Dr. Brownsdon had suggested. Why should not molten metals be filtered—not crude tun-dish pouring, but really effective filtration? The viscosities of molten metals were of the same order of magnitude as water, and their other physical properties seemed to offer no basic hindrance; we had a wide range of refractory materials which could serve as suitable containers and as filtering media; and electric heating gave us ample scope for controlling the temperatures of both the metal and the equipment required. The much more difficult task of the purification of metals by reflux fractional distillation was already an accomplished industrial success. In that field of "sanitary metallurgy" lay a most promising path of progress.

We still wanted to know more of the basic facts of solid inclusions in metals, and here again Professor Hutton was convinced that more could be gained by well-planned synthetical experimentation than by post-mortem studies on normal works products. Some unpublished work carried out by Dr. R. Taylor, at Cambridge, had shown how difficult it was to get inert oxides when shaken up with pure molten metals or otherwise introduced into a metal, to remain embedded, whereas some finely divided inclusions were retained very persistently. Systematic work in that field, perhaps with the help of modern colloid science, should throw light on the cause of the discrepancy.

Commenting on the fact that, until recently at any rate, the industry had held rather curious views about the use of scrap metal, he said that in producing strip brass, for instance, a maximum percentage of scrap was prescribed, whereas for making high-grade special brasses double or treble melting was considered essential. In the former case many seemed to believe in some occult power of the virginity of the copper and other base metals employed. But before and in the early days of the late war he had tackled the problem on a small industrial scale in making nickel-silver, and despite the sensitiveness of the alloy to impurities, he had made perhaps an average of 4–5 tons per week for more than five years, entirely from scrap metals; and he had been asked by a competing manufacturer how he had managed to secure such ductile and high-grade material.

For the production of high-quality metals and alloys, not only must we pay much more attention than did our forefathers to the purity of the virgin metals and scrap materials, but, for the avoidance of contamination improved methods of packing for transport, and of storage. In the future our metals might pass direct from their source to the melting pots in hermetically sealed containers, to avoid deterioration by atmospheric attack or adventitious pick-up of contaminating impurities.

Dr. C. J. Smithells discussing the purity of raw materials for melting, said that some years ago he had tried to devise a systematic method of investigating the effects of minor constituents on the properties of metals and alloys. The experience of the last seven years had filled in many of the gaps which existed in the knowledge of the subject at that time, but he did not think there was any reason to modify the scheme he had then proposed for classifying and studying the effects of both accidental impurities and small intentional additions. The study of those minor constituents, he emphasised, was an important, but quite normal, branch of structural metallography. At times metallurgists were inclined to consider as rather remarkable the fact that the presence of 1 part in 10,000 (0·01 per cent.) of some impurity had a serious effect on the properties of an alloy. Yet if an assumed average grain size of 100 grains per square millimetre was taken, that amount would suffice to cover each grain with a layer of impurity 100 atoms thick all over, and each grain boundary would be a sandwich of impurity 200 atoms thick, between the crystals of pure metal. But the effect produced by any particular impurity was closely related to the way in which it was distributed in the metal. The picture he had drawn was fortunately a rare occurrence. Far more often the impurity segregated into isolated masses instead of forming continuous films. Hence to appreciate the effect of impurities, their effect on structure must be closely studied. Constituents added deliberately to the extent of 1 per cent. or less were so analogous in their behaviour that they might also be considered in the same category.

After discussing in some detail the metallic and non-metallic minor constituents, Dr. Smithells came to the gaseous, and said that obviously the best deoxidiser was hydrogen. Vacuum had no chemical effect at all; it was merely the absence of something which ought to be there—in that case hydrogen. For many years he had been melting nickel alloys in hydrogen, with great advantage; they contained less gas and their mechanical properties were definitely better. But a practical difficulty about introducing it on a large scale was that of the availability of large supplies of such reducing gases. However, he felt sure that the application of such gases—hydrogen or hydrogen and nitrogen—would become common a few years hence.

Mr. A. J. Murphy discussed contamination in melting and gave a few examples encountered in commercial production. When an alloy was in the molten state, he said, conditions were favourable for contamination, for the temperature was relatively high, producing a high rate of chemical reaction, and mobility through convection tended to bring fresh supplies of metal into contact with the contaminating medium, whether it were the walls of the container or the atmosphere over the free surface. At his works, white metal alloys were melted in iron kettles

having capacities up to 5 tons. The ratio of iron surface to weight of molten metal was about half a square inch per pound, and even without any protective wash or lining there was no difficulty in maintaining the iron content of the final ingot below 0·05 per cent.—generally it did not exceed 0·01 per cent.

Ferrous crucibles were used in the melting of aluminium alloys and magnesium alloys. In the former, vigorous measures had to be taken to prevent attack of the aluminium on the iron. Fortunately, that was readily achieved if reasonable care were taken to apply a suitable wash, of the whiting character, between successive melts. Incidentally, the life of the pot was governed only by the rate of oxidation by the flame on the outer surface. Failure to maintain the protective wash could lead to serious contamination, considerably exceeding the 0·6 per cent. iron which was given as a maximum in many specifications for aluminium alloys. There was ample evidence in connection with the aluminium-silicon alloys, for example, to indicate the necessity for a restriction of the permissible iron content to a low figure. Even when the alloy had an intentional iron content of about 1 per cent., irregular variations due to contamination from the pot could not be tolerated.

Magnesium could not be melted safely in fire-clay crucibles because of the intense reactivity of the molten metal, resulting in the reduction of silicates to silicon, which alloyed immediately with magnesium. Aluminium alloys were quite safely melted in fire-clay crucibles. On the other hand, molten magnesium alloys had no appreciable action on iron, and it was regular practice to melt them in pressed steel crucibles. The iron content of magnesium alloys melted in that way did not exceed 0·05 per cent.

After several investigations of the possibilities of sulphur contamination of large castings, such as marine propellers of manganese bronze melted in coal-fired reverberatory furnaces, he had never found any trace of sulphur in the bronze, even when using coal containing 0·84 per cent. sulphur. Except during and shortly after the actual firing the conditions in the furnace were oxidising.

Tin bronzes appeared to be more active than brasses both in the tendency to absorb sulphur from a flame and in their attack on iron. Sulphur contents up to 0·02 per cent. had been found in melts of tin-bronze made in open-flame furnaces burning oil containing 1 per cent. sulphur. At temperatures above 1100 deg. Cent. phosphor-bronze attacked iron and steel rapidly, and it was generally desirable to avoid iron stirring rods. His practice in casting phosphor-bronze, where steel hand ladles were almost essential, was to apply a sprayed protective wash to the ladles and to keep a large number prepared so that they could be used in rotation. Working in that way with a 600-lb. pot of bronze, kept molten for eight hours (and replenished at intervals), the iron content of the bronze did not exceed 0·03 per cent. at any stage, although there were about 100 immersions of a steel ladle in that time.

Professor D. Hanson (Birmingham University) referred to the wide variety of phenomena met with in dealing with the relationships between gases and metals, and to the confusion which existed as to what was meant by "gases in metals." Some substances which were gaseous under normal circumstances, he said, such as oxygen, sometimes entered into metallic systems in which gaseous phenomena appeared to play no part, whereas others, such as carbon, which normally formed no gas phase, might at times be involved in gas-metal reactions. He discussed in some detail the metallurgical importance of gases in metals, pointing out that the characteristic of a gas was that it exerted a pressure. Hitherto the subject heading "Gases in Metals" had had a very wide and rather indefinite meaning, and he suggested a criterion for determining which of the various phenomena should be included as falling within that heading. It was that only those phenomena involving measurable gas pressures should be included. It was only when pressures became measurable that the effects became prominent enough for them to exert any serious practical effect. That would help metallurgists to understand many of the phenomena observed in metals and to arrive at certain conclusions. A gas which was exerting pressure could be eliminated by exposing the metal to an atmosphere which was inert and which did not contain the damaging gas. It was technically possible—though not necessarily an economic process—to de-gas large masses of almost any commercial alloys by such a process, though a long time might be occupied in extracting the gas; it was worth while considering the further examination of that possibility. Sufficient progress in the understanding of "gases in metals" had been made to enable metallurgists to see certain avenues of attack which could not be seen clearly a few years ago, and he was optimistic enough to hope that before very long some of those rather difficult and almost impossible methods might prove to be not quite so hopeless as was at one time supposed.

It was not sufficiently emphasised in the lecture that of all the harmful elements in introducing gas into metal, water vapour was supreme. It could combine with all the common metals, forming oxides and hydrogen. The presence of water vapour in contact with the molten metal was probably a far more potent source, certainly of hydrogen, and in many cases of oxygen, than anything else. It was not always sufficiently realised to what extent water vapour occurred in contact with molten metal. He had seen very few analyses of furnace atmospheres in which water vapour was shown as a constituent; but Allen and Hewitt had published figures; concentrations of water vapour exceeding 10 per cent. of the total volume of the gases were quite common in gas or oil-fired furnaces. If one tried the effect of heating any of the common metals in an atmosphere containing 10 per cent. of water vapour, one would appreciate what a terrible constituent it was to have anywhere near molten metal.

Dr.-Ing. W. J. P. Rohn (Germany) emphasised the important *rôle* played by gaseous impurities, and said it was of special interest that, with very few exceptions, the gaseous impurities encountered in metals were not present in physical solution, but were formed as products of chemical reaction. He pointed to the fact that iron or nickel could contain small traces of both carbon and oxygen at the same time. If such a melt were treated under reduced pressure or in a vacuum, the reaction was influenced in the direction of driving out carbon monoxide from the metal and so obtaining a higher purity. That provided a method of producing iron or nickel of exceptional purity, by first adding a certain excess of carbon and then melting in a vacuum, carbon being one of the most efficient deoxidisers for iron. After having removed the oxygen, melting was continued at a somewhat increased temperature in vacuum. If the lining consisted of magnesia, the excess of the carbon under the influence of the vacuum reacted with the magnesium oxide. As both the products of the reaction were gaseous and volatile at the melting temperature of iron, a metal of very low content of both oxygen and carbon was obtained.

Whilst agreeing with Dr. Smithells that hydrogen was one of the most active deoxidisers, Dr. Rohn pointed out that it was very dangerous from the point of view of gaseous effects during the solidification. Therefore, perhaps Dr. Smithells would accept the proposal that they should first treat the metal with hydrogen as a deoxidiser, then remove the excess of hydrogen by vacuum treatment. One of the most significant proofs of the mechanical quality of a metal or alloy other than its resistance to fatigue was its behaviour under the notched bar impact test. To illustrate the influence of melting and casting under vacuum on that test, Dr. Rohn gave the results obtained on an alloy of about 65 per cent. nickel, 15 per cent. chromium, and 20 per cent. iron. One melt was carried out in an arc furnace, the other in a vacuum furnace of the low-frequency induction type. From both melts ingots of about 600 lb. were poured, and from those ingots a number of notched bar impact test pieces, distributed over the cross-section, were prepared. The open-air melted alloy showed values ranging from 12 metre-kilogrammes per square centimetre, close to the surface of the ingot, to 4 metre-kilogrammes per square centimetre at its centre. By rolling to one-tenth the original diameter of the ingot a value of 16 from the same melt was obtained. Exactly the same alloy, melted and cast in vacuo, gave 18 metre-kilogrammes close to the surface and 14 at the centre of the ingot, while the rolled material gave 26. That showed that vacuum-melted material in the cast condition could have better mechanical properties than material melted under ordinary pressure, even after forging and rolling. Perhaps the time might come when for highly reliable parts of machinery the cast condition of metals freed from gaseous impurities would be preferred.

Mr. G. L. Bailey discussed the removal of undesirable constituents during melting, dealing mainly with the physical and mechanical aspects of the use of deoxidisers and fluxes, rather than with actual foundry practice. He pointed out that when a deoxidising element reacted with a molten metal containing oxide the product might be an oxide of the added element or a more complicated compound produced by secondary reactions between the oxide of the added element and the oxides present in the bath. The particles separating might be either solid or liquid, and in the initial stages of separation they might be regarded as colloidal, forming either a colloidal solution or an emulsion according to whether the particles were solid or liquid. In practice, the success of the deoxidation depended on the readiness with which those colloidal particles aggregated and rose to the surface of the metal. Mechanical disturbance seemed certainly beneficial, and stirring, therefore, with an inert rod after deoxidation was to be recommended provided, as Dr. Brownsdon had pointed out, adequate standing time was subsequently allowed for the particles to rise to the surface. The presence of certain substances was known to favour aggregation of colloidal particles, but metallurgists had no knowledge of the behaviour of particular substances in that respect in colloidal solutions in which non-ferrous metals were the dispersion media, although Giolitti believed manganese to be beneficial in that way in steels.

From the breakdown of colloidal solutions Mr. Bailey went on to discuss the problem of making the particles formed rise readily to the surface, and the advantages of spherical particles from that point of view. It was desirable, he said, to use deoxidisers which produced liquid deoxidation products, for the individual particles would then be spherical drops, and they would coalesce to give larger particles, still of spherical shape. If, however, as suggested by Dr. Brownsdon, fine particles of lithia were more easily removed from molten copper than particles of liquid copper phosphate, the arguments adduced in favour of liquid deoxidation products needed modification. He would be interested to know whether Dr. Brownsdon's remarks were based on actual observation.

Discussing the efficiency of solvent fluxes, he welcomed the suggestion by Dr. Brownsdon that consideration might be paid to shaking metals and fluxes together in the way the chemist shook his separating funnel. He mentioned a recent patent specification (409,910) relating to a method of securing the desired emulsification by pouring a quantity of fluid slag into a ladle and then pouring in rapidly a thick jet of molten metal from a great height.

Mr. A. Logan remarked that the metallurgical effects of the various methods of melting non-ferrous metals appeared to have been sadly neglected, and asked if it were too much to hope that now, being aware of the gaps in our knowledge, the Non-Ferrous Metals Research Association would undertake work with the object of throwing more light on some of the reactions involved in melting under commercial conditions. He suggested, for instance, the study of questions such as the effect of sulphur pick-up on a bronze—whether it was cumulative, and how the sulphur pick-up compared in the same material when melted by gas, coke, or oil. Discussing crucible melting practice, he said that the question of whether crucibles were or were not pervious to furnace gases over the melting range was still one about which very little was known. Claims were made by makers that crucibles were impervious to gas up to a temperature of 1300 deg. Cent., but so far as he was aware no conclusive evidence to support such claims had been put forward.

It was generally accepted, he continued, that the correct furnace condition should be a slightly oxidising atmosphere. A reducing atmosphere was accompanied by undue gas absorption, which was revealed after solidification, by pin-hole unsoundness and low specific gravity. Hydrogen was particularly harmful, and water in any form was to be excluded. For that reason it was very desirable that coke should be stored under cover and dried before use. That remark also applied to the charcoal used for covering. It might not be realised how accurate an indication of melting practice was provided by specific gravity. If an alloy were in regular use and test bars were poured from every cast at a fixed temperature, the resulting specific gravity of the material could be taken as an indication of the melting conditions, and the physical properties could be reasonably accurately predicted.

Discussing fluxes and coverings, Mr. Logan said that years of experience had proved the value of dry charcoal as a covering and a deoxidant. Charcoal alone did not always give complete protection, but, used with phosphor-copper as a stabiliser, no further addition was necessary or desirable. In a recent series of experiments 200 lb. of virgin Admiralty gun-metal were melted thirty-two times. Charcoal only was used as a covering, and the first fifteen melts were made without any phosphor-copper addition. The results without phosphorus fluctuated somewhat, the specific gravity in every case following almost completely the total time of melting. The average figures for the first fifteen melts gave 17·3 tons per square inch tensile strength and 8·57 specific gravity. After the fifteenth melt a small phosphor-copper addition was made to each melt, and the physical properties improved for the next five melts and then remained fairly constant on a higher level. The average of the second series of melts was 19·1 tons per square inch and 8·72 specific gravity, which was almost as good as the figures given by new material, which averaged about 19·5 tons per square inch and 8·75 specific gravity. The tests therefore yielded the highly satisfactory result that the material, after thirty-two meltings, under ordinary works conditions, showed no sign of deterioration either in specific gravity or physical properties.

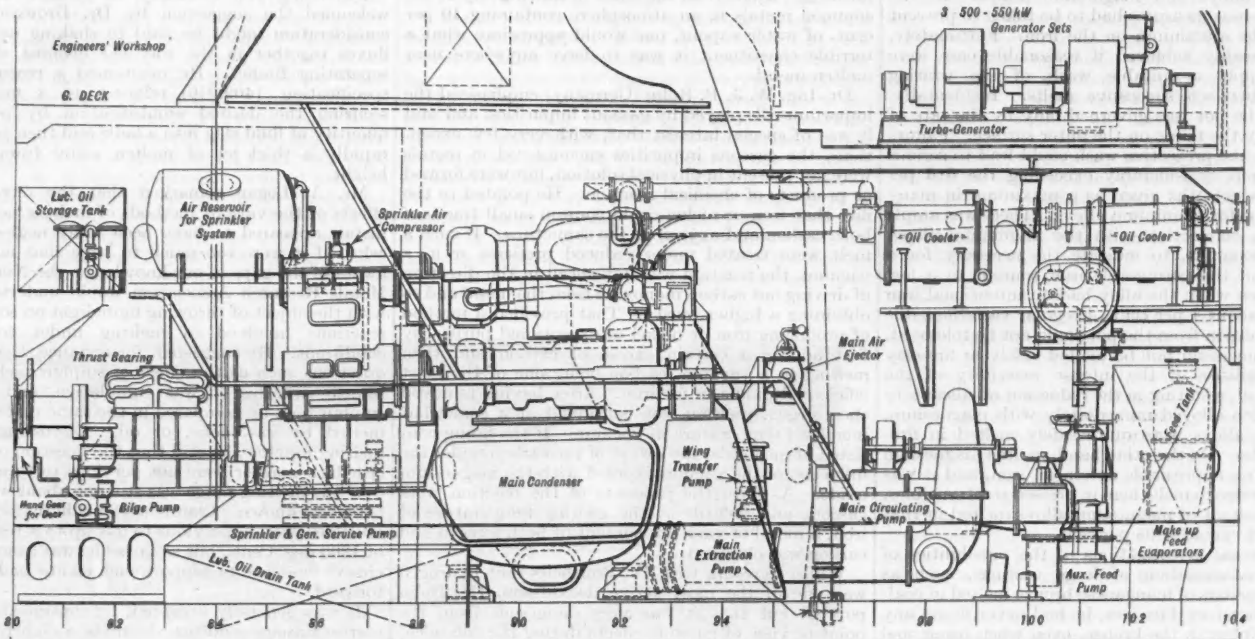
Mr. F. W. Rowe, speaking as a metallurgist responsible for the production of a large quantity of cast metal every week, felt that the most serious trouble in metal melting was that caused by gas absorption. Impurities were catered for in the raw material put into the pot, but the one thing that could not be handled and predicted with certainty was how much gas the metal would absorb and how best to avoid its absorption, or avoid the deleterious effects of its absorption. One method of dealing with gas absorption was to remove the gas that had been absorbed; the second, which was often the more practical method, was to prevent its evolution, which occurred usually at the moment of solidification. In a great many alloys trouble arising from the evolution of gas occurred if the rate of solidification were low, whereas if the speed of solidification in the casting were greatly increased the gas was suppressed and the casting was sound.

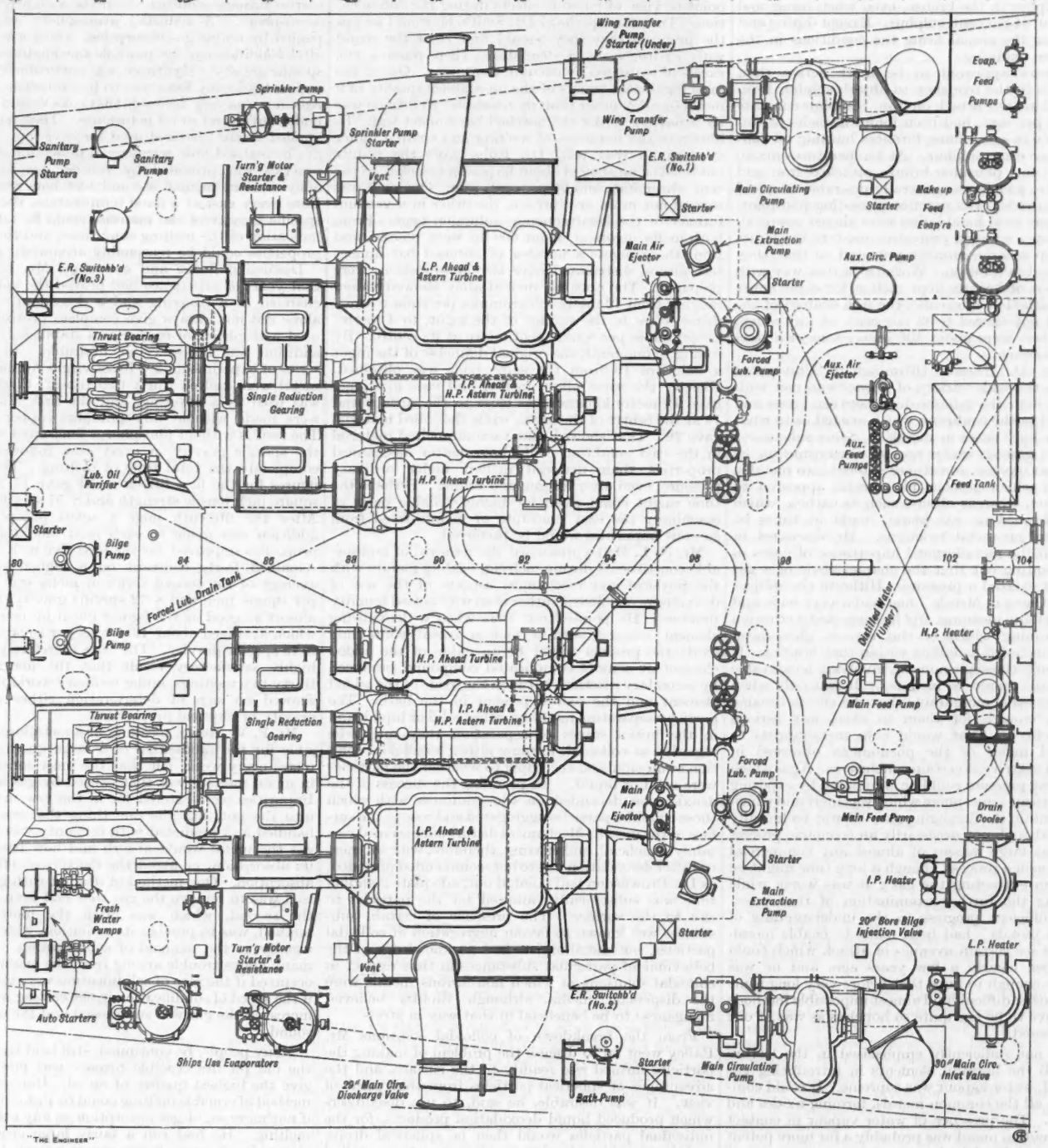
Many people, he continued, still held the view that the old pit fire crucible furnace was most likely to give the highest quality of metal. But the ordinary method of crucible melting could be just as productive, if not more so, of gas absorption as any other form of melting. He had run a fairly large crucible plant alongside an open flame reverberatory furnace, on

P. AND O. LINER "STRATHMORE"—ENGINE-ROOM ARRANGEMENT

VICKERS - ARMSTRONGS, LTD., BARROW - IN - FURNESS, ENGINEERS

(For description see opposite page.)





similar classes of alloys year in and year out, and despite the seeming disadvantage of the reverberatory type for melting copper alloys and general classes of engineering bronzes, he had not noticed any diminution in quality; indeed, the results were rather the reverse in that furnace, as against the crucible melting furnace. He had also melted the common engineering bronzes, such as phosphor-bronzes and gun-metal and some of the nickel-bearing bronzes, in the arc furnace, which was so popular in the United States for bronze foundry use, and had found a distinct improvement in the general quality of the metal. Certain types of absorption trouble were in fact entirely avoided in the arc furnace. In certain engineering alloys, such as phosphor-bronze, and particularly bronzes containing a proportion of from 2 to 10 per cent. of nickel, the danger of sulphur absorption, probably from sulphur dioxide or some other sulphurous gas, was very real. In one case he had traced the trouble to a high-sulphur-bearing fuel. Fuel oil sometimes contained up to 1¼ per cent. of sulphur.

Mr. W. R. Barclay, discussing fluxes from the point of view of their refining action, pleaded for simplicity. A few years ago there had been a great tendency to advocate complicated fluxes for non-ferrous alloys, and many claims were made for them. The number of fluxes that could be used in practice was limited. Confining himself to nickel alloys, he emphasised their essential simplicity and pointed out that in the use of fluxes for refining, consideration must always be given to the type of furnace employed. If the furnace were of the electric arc pattern, for instance, it was very difficult, if not impossible, to find a better flux than one of calcium silicate. Beginning with 2 parts of sand and 1 of lime, one could vary the viscosity of the flux very considerably; it had a powerful solvent action on oxides and could be readily skimmed from the surface. Skimming was important and should be effected with tools which in themselves would not complicate the problem of refining. He had seen some very ingenious skimmers made from a kind of wood which was not easily combustible, and the skimming effect was very efficient indeed.

In the crucible melting of nickel alloys, it was very difficult to improve on borates. The old-fashioned moulders of nickel-silver a generation ago had contended that no flux was so good as a whiskey bottle. There might have been an ulterior motive, but, on the other hand, whiskey bottles were lead-free, and one might introduce a very serious impurity by using a flux containing lead. If the use of fluxes to aid refining was to be at all efficient it was obvious that more than one treatment was necessary. It was not sufficient just to cover the metal with a flux and expect that one need only carry on and allow the flux to do the work. Sometimes, when dealing with dirty scrap, one had to renew fluxes once or twice or even oftener during the melting operation. Finally, Mr. Barclay suggested that a fairly close study of the "Proceedings" of the Society of Glass Technology would prove fruitful, for the glass technologists had done an immense amount of work in studying the solvent action of both borates and silicates.

Mr. W. F. Brazener, referring to the melting of copper in crucibles, said no one would disagree with Dr. Brownsdon that the solubility of cuprous oxide in molten copper led directly or indirectly to many troubles. It was necessary, however, not to lose sight of the fact that that phenomenon was the basis of the successful refining of copper in reverberatory furnaces for the production of the ordinary tough-pitch variety.

In that process the copper was nearly always contaminated with sulphur, which might have been present in the original charge or might have been absorbed from the products of combustion. In any case, its reduction to harmless proportions was effected by oxidation, and it could readily be believed that such oxidation would be an extremely difficult and lengthy process, but for the absorption of oxygen by the copper and the solubility of the cuprous oxide so formed. Dealing with the disturbing influence of hydrogen on molten copper, he said that research had shown that with 0·04–0·05 per cent. of oxygen, corresponding to approximately 0·35–0·45 per cent. of cuprous oxide, the hydrogen which could remain in the copper was comparatively insignificant. It might be suggested that in crucible melting, if copper of a deoxidised variety was required, the introduction into the melt of copper oxide before the addition of a deoxidant would tend to remove dissolved hydrogen. If strict limits were imposed for the residual percentage of the deoxidising element, the process would be difficult to operate. Possibly, however, those difficulties might be overcome by a close control of melting technique.

With regard to dissolved gases in tough-pitch copper, he said it would be expected that slow pouring of the molten metal into the ingot mould would give a much better chance for those gases to escape, and to some extent that was so. Yet in large-scale trials it had been found that tough-pitch copper ingots cast in water-cooled moulds showed, after rolling, much greater freedom from blister trouble than was the case with rolled metal from ingots produced in the ordinary solid moulds. At a rough guess, solidification for similar sized ingots was three times as rapid in the water-cooled mould, and yet to all outward appearances gas inclusions were less.

In the re-melting of dirty scrap in crucibles a great deal of trouble could be avoided if the correct flux were placed in the bottom of the crucible so that the metal could melt through it. An objection was that, generally speaking, the refractory was attacked by the flux and the melting cost was thereby increased. A special type of flux-resisting crucible was now available, however. If dirty scrap were melted without proper fluxing, the resulting ingots always displayed the typical cauliflower top. Broken glass or sal-ammoniac had been used in the past as a flux for particularly dirty material, and considerable benefits were derived from that treatment.

Mr. A. G. Robiette commented on the work of the British Non-Ferrous Metals Research Association on porosity, which had been shown to be caused largely by the absorption of furnace gases during melting, and said that the rational solution was to adopt electric melting and so melt under conditions immune from such influences. During the last six or seven years, he said, there had been an almost complete conversion of the wrought brass industry to electric melting, and the productive capacity of electric melting furnaces installed in this country alone exceeded 100,000 tons per annum. Considerations of economy as well as of quality had guided the brass ingot producers in that policy. Having pointed out that the vertical channel induction furnace, used in the rolling mill, was not generally applicable to the production of castings, he proceeded to discuss the qualities of the indirect rocking arc furnace, developed in America to meet the need of the foundry or the small non-ferrous rolling mill in which the output covered a range of compositions that might be required at relatively short intervals. It would, he said, melt practically all non-ferrous alloys economically, including nickel-chromium-iron alloys, copper-nickels, brasses, bronzes, and even aluminium alloys. The melting was rapid—from twenty to twenty-five minutes per charge of copper alloys—and the metal losses were comparable with those in induction furnace practice. The atmosphere was reducing, consisting mainly of carbon monoxide and nitrogen, both of which were innocuous to copper alloys. Owing to its low thermal storage, it was rapidly heated from the cold state in about thirty minutes and was ideal for intermittent operation.

Dr. Brownsdon did not reply to the discussion.

(To be continued.)

The New P. and O. Liner "Strathmore."

No. I.

ON Friday afternoon, September 13th, the new 23,400-ton twin-screw, turbine-driven liner "Strathmore," built and engined by Vickers-Armstrongs, Ltd., for the express service of the Peninsular and Oriental Steam Navigation Company, between the United Kingdom and Bombay, left Liverpool for the Clyde, where, during Saturday and Sunday last, she completed successful trials. A large party of guests was invited by the owners and builders to inspect the ship, and to make the trip round to Tilbury which was reached on Tuesday afternoon.

In what follows we give a short account of the principal features of the hull, the passenger accommodation, the main propelling, and some of the auxiliary machinery.

The engraving of the liner reproduced on page 294 shows her external appearance, whilst another tone engraving on page 294 and the drawing reproduced on page 288 show clearly the general arrangement of the geared turbines and the auxiliary machinery in the main engine-room.

It may be recalled that the "Strathmore" was launched from the Barrow Naval Yard of Vickers-Armstrongs, Ltd., on Thursday, April 4th, and that an account of the launching ceremony, with some advance particulars of the ship, appeared in our issue of April 12th. She is of special interest in that she is the largest and fastest vessel ever constructed for the service between Europe and India. In the accompanying table we give the principal particulars and dimensions of both the hull and the propelling machinery:

Hull Particulars.

Length between perpendiculars	630ft.
Length overall	665ft.
Breadth moulded	82ft.
Breadth overall	84ft.
Depth moulded to "F" deck	38ft.
Depth moulded to "E" deck	47ft. 6in.
Displacement	28,400 tons
Draught	30ft.
Gross tonnage	24,000
Designed contract speed	20 knots

Passenger Accommodation.

First-class passengers	445
Tourist class passengers	665
Officers and crew	510

Propelling Machinery.

Type: Parsons twin-screw single-reduction geared turbines	
Designed output	24,000 s.h.p.
Astern power: 70 per cent. of ahead, approx. 16,800 s.h.p.	
Turbine speed	1715 r.p.m.
Propeller speed	112 r.p.m.
Type of condenser	Weir regenerative
Total surface	25,000 square feet
Working vacuum: 28in. at 30in. bar. and 86 deg. Fah. sea temperature	
Type of boiler: Oil-fired Babcock and Wilcox water-tube	
Number of large boilers	Four
Number of small boilers	Two
Safety valve blow-off pressure	450 lb. per sq. in.
Working pressure	425 lb. per sq. in.
Total superheated steam temperature	725 deg. Fah.
Total generating surface, four large boilers	29,860 square feet
Total superheating surface, four large boilers	4,280 ,,
Total air heating surface, four large boilers	32,000 ,,
Total generating surface, two small boilers	7,170 ,,
Total superheating surface, two small boilers	1,434 ,,
Total air heating surface, two small boilers	8,000 ,,

Turbo-generator Sets.

Type of sets: B.T.H. single-reduction geared turbine	
No. of sets	Three
Total designed output	1500 to 1650 kW
Turbine speed	1500 r.p.m.
Generator speed	500 r.p.m.
Voltage	220 volts
Working steam pressure	400 lb.
Working steam temperature	725 deg. Fah.

Emergency Generator Set.

One 110-kW, six-cylinder Allen oil engine driven set

Hull Design and Safety Equipment.

The eight decks, alphabetically designated A to H, include the promenade decks and are all intended for the use of passengers. In order to provide a maximum margin of safety at sea, the hull of the ship is subdivided into twelve transverse watertight compartments up to the level of "F" deck. She has a continuous double bottom from the collision bulkhead to the after end of the shaft tunnels, and is divided transversely and longitudinally to provide a large number of tanks for fresh water, boiler-feed water, water ballast, and oil fuel. Further, the vessel, from the forward cross oil-fuel bunker to the after end of the engine-room, is protected by a complete double skin up to the water line.

On "A" deck there is a full complement of lifeboats, including two motor boats, fitted with patent "Skate" launching gear and carried in davits of the latest Welin Maclachlan pattern. These boats are designed to accommodate the whole ship's company should necessity arise, or to provide the usual service of craft for the conveyance of passengers between the ship and the shore when she goes cruising. For the safety of the vessel in case of fire, the Lux-Rich system of smoke-detecting and alarm has been fitted, together with a complete installation of Mather and Platt Grinnell sprinklers arranged so that a fire in any part of the vessel so protected shall be subdued automatically, while for additional safety the whole of the woodwork in the passenger accommodation and crew's quarters has been covered with fire-resisting paint; fireproof doors are fitted in all the main alleyways.

In order to meet the varying climatic conditions through which the ship must pass in the course of her employment, Carrier air-conditioning plant has been installed to supply the first-class dining saloon with fresh air of regulated temperature. Beside this, the Thermotank mechanical system of ventilation is fitted in all public rooms and in the accommodation for both passengers and crew.

Cargo Arrangements.

The cargo space includes provision for general and refrigerated cargo. Insulated cargo will be carried in Nos. 1, 2, and 3 holds and between decks forward. Nos. 4, 5, and 6 lower holds aft will be used for the stowage of general cargo, and provision is made for the carrying of passengers' motor cars. Cargo will be worked by means of derricks served by 3 and 5-ton winches, distributed at suitable places in the vessel, while in addition four 10-ton derricks are fitted. The lifting arrangements are of the latest and most efficient type for the rapid handling of cargo, twenty-two electrically driven cargo winches being provided.

For mooring the ship, a powerful Clarke Chapman electric windlass, with extended ends for warping, is fitted on the forecastle deck, the motors being situated under deck. Two electric warping capstans of the same make are also fitted on "E" deck aft.

The steering gear is of Brown Brothers electro-hydraulic type, fitted with telemotor control from the navigating bridge and mechanical control from the docking position on "C" deck aft.

The total complement of officers and crew is about 515. The senior officers and engineers are accommodated in single-berth cabins, while the petty officers have two-berth cabins, each cabin being comfortably furnished in the latest style.

First-class Cabins and Public Rooms.

A special feature of this liner is the inclusion of two Vice-Regal suites, each comprising a dining-room, sitting room, verandah, bedroom, and bath-room. These suites are on "D" deck and on the

same deck are six *cabins de luxe*, for which the furniture and decorations have been specially designed. Shops are also arranged on this deck. The main cabin accommodation for 445 first-class passengers in 199 single and 123 two-berth rooms, is grouped on "C," "D," and "E" decks, and on "F" deck forward of the first-class entrance. A considerable number of the cabins have a private bathroom attached. The remainder have both hot and cold running water laid on to the washbasins. All fittings and furnishings throughout are in conformity with the main scheme of decoration, in which the modern note is happily expressed.

The first-class dining saloon is amidships on "F" deck, and it runs the full width of the ship, 82ft., and has a length of 68ft. Tables are provided for 258 passengers. The central portion of the room is raised to give additional height, an advantage when steaming in tropical waters. In this ship, however, conditioned air is supplied to the dining-room through special ventilators and an equable temperature is maintained in all conditions of climate by a plant supplied by the Carrier Engineering Company, Ltd., London. Quite near is a small children's dining-room, while in the *foyer* leading to these rooms, which is served with lifts and a staircase, there is a large-scale world map outlined in blue or white sycamore wood, which shows the P. & O. and associated companies' trade routes. The principal public rooms are grouped on "B" deck, at the forward end of which is the library and writing room.

The arresting feature of this room is its unusual shape, determined by the curve of the bridge front. Following out the suggestion of curvature thus given, large bow windows are fitted port and starboard, and are incorporated in the general lay-out of the room, since they form the semi-circular sides. From these the ceiling rises in a series of covings.

Passing aft through the entrance hall the lounge hall is reached, and adjoining it there is an enclosed dancing space and still further aft a verandah café. On "C" deck there is also an open-air café and cocktail bar, just forward of the "Lido" or deck bathing pool. Ample space for sun-bathing is reserved. Forward of the bridge there is a children's nursery and a playing deck. A large sports and games space on "A" deck has a length of 275ft. and runs to the full width of the ship, 82ft.

Tourist Accommodation.

The accommodation for tourist class passengers is arranged on "F," "G," and "H" decks, some 280 cabins being provided for the full complement of 665 tourist passengers. The tourist rooms include a dining saloon, a smoking-room, and a lounge, also a verandah café and children's nursery.

Navigating Equipment.

The navigating equipment on the bridge and in the chart room includes a compass equipment of the Sperry gyro type and repeaters on the upper bridge, the pilot bridge, and the wireless telegraph room, while a course recorder is fitted in the wheel house. In connection with the Brown Brothers electro-hydraulic steering equipment, a Sperry two-unit gyro pilot is also provided. The wireless equipment was designed and supplied by the British Wireless Marine Service, and includes a direction-finder. Broadcasting arrangements for music and a portable sound picture equipment are carried. Other instruments include an electric log in the chart house, operated from a register on the taffrail, and a Marconi high-frequency Echometer. The usual loud-speaking telephones and electric telegraphs between the bridge and the engine-room and steering-room are provided. It is of interest to record that for the low-voltage circuits associated with the safety and navigation of the ship, two emergency storage batteries, each comprising eleven Exide cells, which are charged from the ship's 220-volt system, are provided.

Propelling Machinery.

As will be seen from the accompanying drawings, the vessel is propelled by twin screws, each driven by a set of Parsons turbines, through single-reduction gearing. Each set comprises one high-pressure, one intermediate-pressure, and one low-pressure turbine, working in series and driving separate pinions engaging with the main gear wheel. The high-pressure turbine is of the impulse reaction type, the first stage consisting of an impulse wheel with two rows of blades, and the remainder of six stages of reaction blading mounted on a hollow drum of forged steel. The intermediate-pressure turbine is of the reaction type, having seven stages of blades mounted on a hollow forged steel drum. The low-pressure turbine is of the single-flow type, having sixteen rows of reaction blading mounted on forged steel disc wheels.

The astern turbines for each set comprise, one high-pressure and one low-pressure, working in series. The H.P. astern turbine is incorporated in the intermediate cylinder, having one impulse three-row wheel, and the L.P. astern turbine is incorporated in the L.P. casing, and consists of one two-stage impulse wheel, followed by five stages of reaction blading.

The rotor shafts of all the turbines are packed with both labyrinth and carbon packing, and "Michell" type pivoted adjusting blocks are fitted. All the turbines are designed to run at 1715 r.p.m., while the gear ratio is such that the propellers make 112 r.p.m. The nozzle vanes and blades which form part of the impulse section of the turbines are made of special stainless steel, supplied by the English Steel Corporation, of Sheffield, which also manufactured the steel forgings for the main gearing, turbine rotors and propeller shafting.

The turbines are connected by flexible couplings to nickel steel pinions, which engage with the main wheels on the propeller shafts. The gearing is of the double helical single-reduction type, having Vickers-Bostock-Bramley patent "enveloping" gear teeth. The gear wheels consist of cast iron centres, with forged steel rims shrunk on, and securely fastened to the gear wheel shaft. Central bearings are not fitted to the pinion shafts. The shaft bearings for both turbines and gearing are supplied with forced lubrication, and the thrust blocks, which are of "Michell" type, are placed on the shafts close up to the gearing.

The propellers, which were supplied by J. Stone and Co., Ltd., are of the built-up type, each having four blades of manganese bronze, secured to cast steel bosses by mild steel studs and gunmetal cap nuts. A cast iron cone is fitted over each propeller nut. Electrically operated turning gear is provided for the turbines and shafting.

The main condensers shown in the drawing herewith are of the Weir "Regenerative" type, suspended from the low-pressure turbine casings, spring supports being fitted to relieve the load on the turbines. The total cooling surface in the condensers is 25,000 square feet, and they are designed to maintain a vacuum of 28in. of mercury with the barometer at 30in., with a sea water temperature of 86 deg. Fah.

The steam generating installation, to which we shall refer in our next article, consists of six Babcock and Wilcox high-pressure marine type boilers. There are four large boilers and two small boilers, and all are fitted with superheaters and tubular air heaters. The blow-off pressure of the boilers is 450 lb. per square inch, the working pressure, 425 lb., and the steam temperature 725 deg. Fah. Steaming under most unfavourable weather conditions on the Clyde, the "Strathmore" set up a remarkable performance on the measured mile off Arran. Her mean speed during two runs on the mile was nearly 22 knots, or 2 knots in excess of contract requirements, while her maximum speed was over 22¼ knots.

(To be continued.)

XVIth International Congress of Navigation, Brussels, 1935.

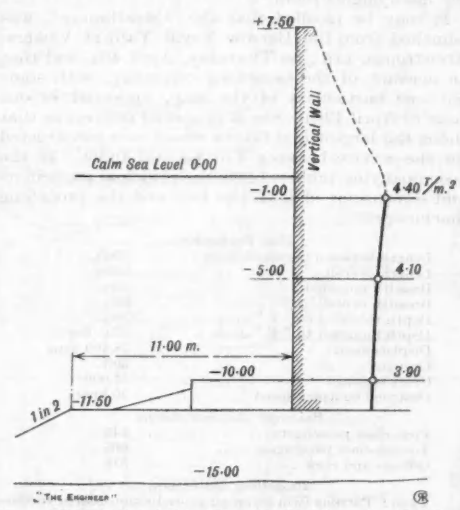
No. II.

(Continued from page 274, September 13th.)

WE continue hereunder the abstract of Signor Coen Cagli's report to the Congress on Vertical Wall Breakwaters, and the failures of the two important structures of this type at Catania in Sicily and Algiers respectively. The first part of Signor Cagli's paper appeared in our issue of September 13th, and concluded with a statement of the lessons deduced by him from the history of the failure of the two breakwaters.

Model Experiments at Lausanne and Wave Observations at Genoa.

With a view to checking these deductions we recently undertook, in collaboration with Professor A. Stucky, the Director of the Hydraulic Laboratory at the University of Lausanne, a preliminary series of tests on small-scale models, the results of which, incomplete as they are, appear to us to be very significant. We desired to verify by these tests whether storm waves retained in front of a vertical wall their orbital movement or if they changed, as some writers have maintained, into standing waves.*



Storm of March 12th, 1934. Wave Height 4·5 m., Length 110 m.

Fig. 11—Principe Umberto Mole, Genoa: Diagram of Recorded Wave Pressures

The results furnished so far by observations of wave pressures at the port of Genoa and by the tests on small-scale models show very clearly that the transformation of a trochoidal into a standing wave in front of a vertical wall is not verified. The Genoa observations, of which the results have been published in several scientific and technical journals, have been going on for four years, piezometers of the Levi type having been installed in the outer face of the Principe Umberto Mole, where the sea has a depth of 15 m., corresponding to about one-tenth of the longest storm waves anticipated there. The observations were made during storms always characterised by waves meeting the mole at about a right angle, and of which the dimensions never reached the anticipated maximum length nor exceeded 5 m. in height. The observations so far made show :—

(i) That horizontal stresses (that is, excess of positive or negative pressure, according as it is either landwards or seawards, compared with calm water conditions exerted by oscillating waves) reach a positive maximum value near the level of calm sea ;

(ii) That the maximum effort is very nearly equal in all cases to the hydrostatic pressure corresponding to the height of the unobstructed wave in the offing ;

(iii) That this effort diminishes rapidly above calm sea level, even if the wave, in contact with the wall goes over the crown of the parapet, the crests of the wave reaching a height above calm sea level that usually exceeds—often very considerably—the theoretical height, that is the level corresponding to an amplitude of oscillation double the height of the incident wave. This fact alone proves the partly dynamic nature of the forces exerted by the waves.

(iv) That the positive effort diminishes, on the other hand, below calm sea level more slowly as the ratio of the height to the length of the wave is lessened. In the case of waves of ordinary proportions the effort is reduced at the foot of the vertical wall to a value which always exceeds half the maximum, while it remains practically uniform and equal to the maximum from the calm sea level to the foot of the wall in the case of waves which are exceptionally long as compared with their height.

(v) That the negative effort below the trough of the wave in contact with the wall is practically equal at all levels to the corresponding positive effort.

The tests on small-scale models gave results that agree perfectly with the actual observations recorded at Genoa, thus demonstrating that the method of research by means of tests on such models, based on the law of mechanical similitude, is strictly applicable to the study of wave effort ; that it is under the trochoidal form, and not as standing waves, that waves of oscillation, in violent storms at any rate, exert their maximum effort against vertical walls ; and that the pressures due to such waves notably exceed those which would be produced by a standing wave engendered by the same trochoidal wave. The results of the experiments on models, so far as can be recorded up to date, may be summarised as follows :—

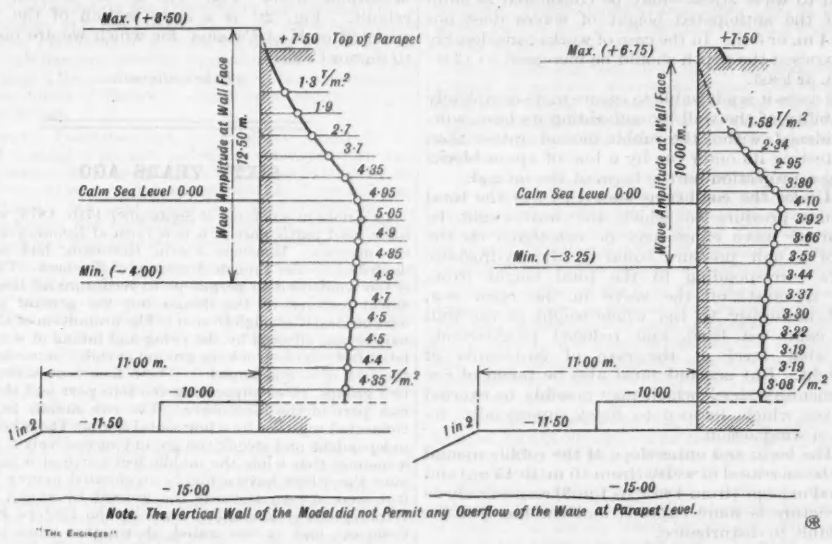
(1) During the storm at Genoa on March 12th, 1934, when there was a swell of about 4·5 m. height and a length of 110 m., the highest pressure recorded when the waves followed each other in regular and almost uniform groups was almost the same throughout the height of the vertical wall from the level −1·0 m. to −10·0 m. with a maximum value of 4·4 tons per square metre—Fig. 11. Tests on a small-scale model of the mole confirmed these results : waves equivalent to a length of 110 m. and 5 m. high produced a maximum pressure of 5·05 tons per square metre, the small differences between these results and the values obtained by direct measurement on the face of the jetty being clearly the consequence either of the greater height of the wave or of the higher figure of the ratio $\frac{h}{L}$ in the former case.

The same model was also subjected to the action of

* The term "standing wave" used by Signor Cagli is equivalent to the French *clapotis*, which has a special technical use to describe the wave form resulting from the superimposition and consequent "piling up" of two wave undulations in opposite directions ; as for instance the result of the meeting of an unbroken wave reflected by a vertical face of a breakwater wall in deep water and an on-coming wave. The theory of *clapotis* assumes that the orbital movement of the liquid particles is partially changed to an oscillatory movement, up-and-down, in a more or less vertical plane. The term "standing wave" has already a well established English signification in connection with the hydraulics of overflow weirs, &c., and it may be suggested that the use of this term, in connection with sea waves to denote an entirely different phenomenon, is unfortunate. *Coincident* or *conjunctional* wave might be a more appropriate equivalent of this special technical meaning of *clapotis*.—Ed. The E.

a standing wave engendered by the same trochoidal wave, 5 m. high and 110 m. long. The pressures obtained are indicated in the diagrams—Figs. 12 and 13. Comparing the diagrams we find that the trochoidal wave rises much higher than the standing wave, the former pouring over the crest of the parapet wall, which is at a level of +7·5 m., whilst the crest of the standing wave only reached a level of +6·75 m.

(2) Having subjected a small-scale model of the Mustapha Jetty at Algiers to the action of trochoidal waves having the same characteristics as the rollers observed during the storm of February 3rd, 1934, namely, 9 m. high and 185 m. long near the jetty, and been subjected to the impact of waves 7·5 m. high and 155 m. long, similar to those observed during the storm of March 26th, 1933, the results of the test showed that the breaking of these waves cannot really have happened, observers who believed the contrary probably having taken for the effect of true breakers the masses of water that poured over the parapet of the mole. The tests—Figs. 17 and 18—further showed that the pressure exerted by the waves against the wall was almost uniform, with a maximum of 7·7 tons per square metre, closely analogous with the results of the Genoese experiments. The waves exerted a total pressure of 120 tons

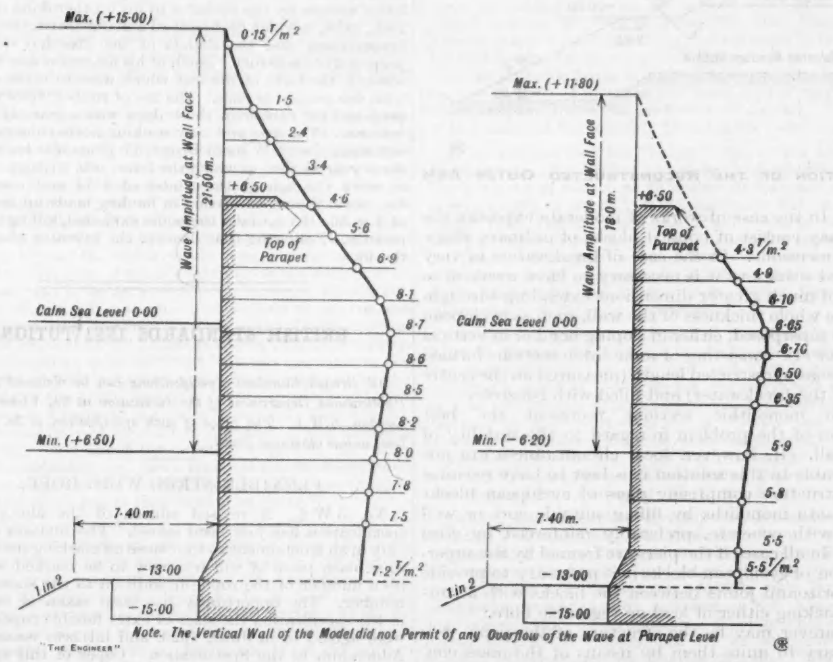


Wave Height 5 *m., Length* 110 *m.* — "*Standing Wave*," *Height* 10 *m., Length* 110 *m*

FIGS. 12 AND 13—PRINCIPE UMBERTO MOLE, GENOA: MODEL EXPERIMENTS. WAVE PRESSURES

of standing waves engendered by these trochoidal waves, we obtained the following results :—

The total pressure per lineal metre of jetty exerted against the wall reached about 147 tons in the case of a trochoidal wave, compared with 109 tons in the case of the standing wave—Figs. 14 and 15—a difference of 35 per cent., whereas in the case of the Genoa mole there was a corresponding difference of 26 per cent. This difference is to be anticipated in view of the lesser ratio of height to length in the case of Genoa as compared with that at Algiers. The model tests give a total pressure against the wall of the Mustapha Jetty of 105 tons per lineal metre in respect per lineal metre of the mole, producing an intensity of pressure on the rubble foundation of 6·7 kilos. per square centimetre, a pressure which the wall, 12 m. wide, would clearly have withstood if it had been, like the Mustapha Jetty, constructed of monolithic piers as originally planned. It can be understood, on the other hand, that the mass concrete superstructure, with the blocks immediately beneath, having a total weight of about 150 tons per lineal metre, considerably reduced, no doubt, by the upward pressure of water exerted on the under surface of the blocks, through the unbedded horizontal joints, might have been displaced by a horizontal pressure of about 60 tons, and



Wave Height 9 *m., Length* 185 *m.* — "*Standing Wave*," *Height* 18 *m., Length* 185 *m.*

FIGS. 14 AND 15—MUSTAPHA JETTY, ALGIERS: MODEL EXPERIMENTS. WAVE PRESSURES

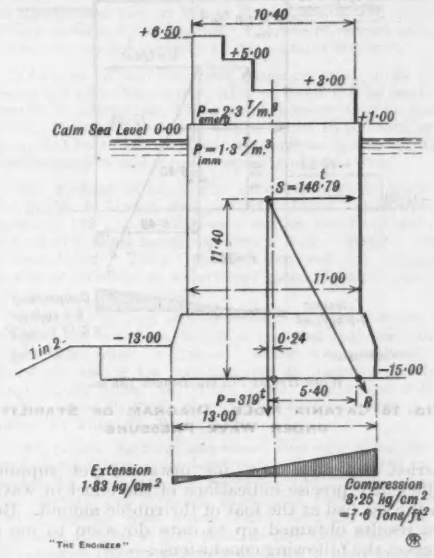
of the part below calm sea level, and a total pressure of 42 tons against the part above that level, both agreeing closely with the corresponding pressures obtained by calculation. Such horizontal forces would produce maximum unit pressures on the rubble mound at the base of the wall as high as 8·2 kilos. per square centimetre—Fig. 16—certainly an excessive load, but one which, very likely, was not actually realised by reason of the intervention of other factors of resistance, such as the continuity of the mass concrete crown of the breakwater, and the rise of the water level on the harbour side of the jetty as a result of the rise of level outside.

(3) The model of the Catania mole having, in turn, that subsequently the blocks in the lower layers would have been, in their turn, and still more easily, thrown over into the harbour.

(4) In none of the three cases submitted to test with small-scale models could we obtain breaking of waves, or even an appearance of breaking, in front of the wall, although the length of the waves was increased beyond any admissible proportion in regard to their height.

In all three cases there was produced a maximum unitary pressure almost uniform over the whole immersed part of the wall from the level of −1·0 m. to the base of the vertical wall, and practically equal to the hydrostatic pressure due to the height of the wave in the open. It is therefore justifiable to conclude that if the depth of the sea at the site of the work exceeds, as is usually the case, twice the height of the greatest storm waves to be anticipated in the locality, and if the foot of the vertical wall face is at a depth of at least one-and-a-half times the same height, the danger of waves completely breaking should be considered as non-existent.

On the other hand, it has been possible to ascertain that under these conditions the width of the berm at the base of the wall and the inclination of the side slope of the mound, on the seaward face, do not affect in any way (within practical limits, at all events, say, a berm width of 15 m. and a slope of 1 in 3) the intensity of the stroke exerted by the waves against the wall. But while

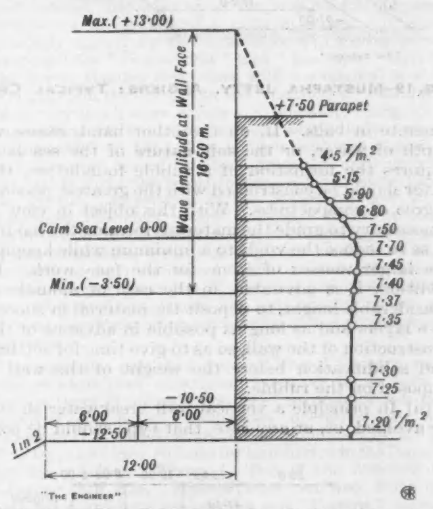


Wave Height 9 *m., Length* 185 *m.*

FIG. 16—MUSTAPHA JETTY, ALGIERS: DIAGRAM OF STABILITY UNDER WAVE PRESSURE

under the conditions described it is possible to exclude the risk of the complete breaking of waves, it is not impossible that, especially in storms accompanied by very high wind, waves retarded in their propagation by the progressive decrease in depth and by the effect of the slope of the rubble mound, may, under the influence of the wind, break superficially and so produce against some part of the face of the wall pressures that are much more intense than would be exerted if the same waves remained purely oscillatory until their contact with the vertical face.

Unfortunately, neither the observations at Genoa nor the laboratory experiments have hitherto produced data as regards the intensity and distribution



Wave Height 7·5 *m., Length* 155 *m.*

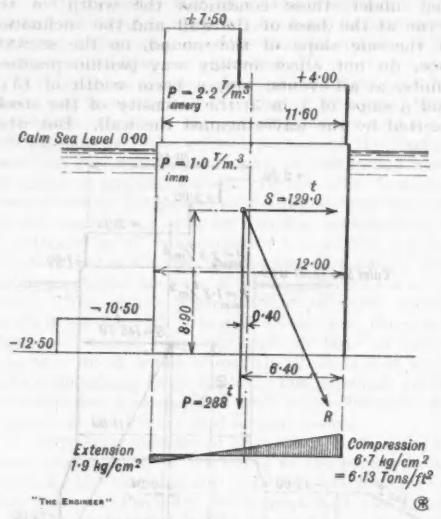
FIG. 17—CATANIA EAST MOLE: MODEL EXPERIMENTS. WAVE PRESSURES

of these exceptional pressures. It should, however, be noted that waves accompanied by strong wind, and consequently of comparatively short length, result in a total effort exerted against the wall very much less than that produced by waves, of the same height and of much greater length, propagated in the complete absence of wind. It should also be observed that the purely dynamic force exerted by the superficial breaking of a wave, exhausting itself in a comparatively short time, affects the resistance of the structure to shear much more than the resistance to overturning or slipping. It follows, in my opinion, that if a breakwater is designed with the requisite margin of safety for withstanding waves of oscillation of the maximum height to be anticipated in a locality, not accompanied by wind, the monolithic structure of the wall or its piers may suffice to ensure the requisite stability in

face of the enhanced stroke of waves which happen to break superficially on approaching the wall by reason of wave action.

General Conclusions.

These preliminary results of direct observations and of tests on small-scale models certainly cannot be regarded as exhaustive. The experiments now being



Wave Height 7·5 m., Length 155 m.

Fig. 18—Catania Mole: Diagram of Stability under Wave Pressure

carried out have not, for instance, yet supplied sufficiently precise indications of the effect of waves on the sea bed at the foot of the rubble mound. But the results obtained up to date do seem to me to suggest the following conclusions :—

(i) If the depth of water and the rocky nature of the sea bed allow of its application, the best system of construction consists in founding the wall directly on the sea bed, previously levelled by the deposit of

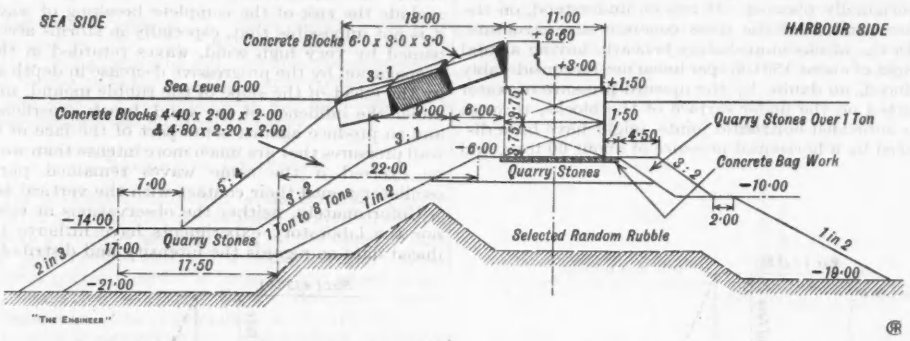


Fig. 19—Mustapha Jetty, Algiers: Typical Cross Section of the Reconstructed Outer Arm

concrete in bags. If, on the other hand, excessive depth of water, or the soft nature of the sea bed, requires the formation of a rubble foundation, the latter should be constructed with the greatest possible degree of compactness. With this object in view it is necessary to grade the materials forming the mound so as to reduce the voids to a minimum while keeping the larger masses of stone for the face work. In addition, it is advisable, in the case of mounds of considerable height, to deposit the material in successive layers and as long as possible in advance of the construction of the wall, so as to give time for settling and solidification before the weight of the wall is imposed on the rubble.

(ii) In principle a vertical wall breakwater should be avoided, or, at any rate, that type should be con-

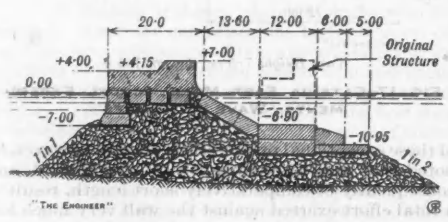


Fig. 20—Catania East Mole: Typical Cross Section of Reconstructed Outer Arm

sidered as disadvantageous, if the conditions are conducive to the complete breaking of storm waves.

In the present state of experience, observation, and research, both theoretical and experimental, it appears that any danger of the complete breaking of storm waves in front of a vertical wall breakwater is excluded when the depth of water in front of the breakwater is at least twice the height of the largest storm waves likely to be encountered in the locality, whatever their length, within the limits of recorded observation—that is, a length of 35 to 40 times the height.

(iii) Within practical limits of depth, imposed by the present state of constructional technique, the foot of a vertical wall should be at a greater depth below sea level in proportion to the exposure of the structure, so that the largest storm waves may retain, when passing over the slope and berm of the rubble mound, their oscillatory nature ; and that the mound itself should not be exposed to undermining by the motion of the sea. Experience shows, so far, that a depth of about 10 m. at the foot of a vertical wall—that is, the part of the vertical wall face directly exposed to wave stress—may be considered as sufficient if the anticipated height of waves does not exceed 4 m. or 5 m. In the case of works considerably more exposed the depth should be increased to 12 m. or 13 m. at least.

In all cases it is advisable to ensure more completely the stability of the wall by embedding its base, suitably widened, within the rubble mound, rather than by protecting its outer toe by a line of apron blocks forming a projection on the berm of the mound.

(iv) Under the conditions stated in (iii) the total maximum pressure to which the wall might be exposed by wave effort may be calculated on the basis of a unit pressure equal to the hydrostatic pressure corresponding to the total height (from trough to crest) of the wave in the open sea, applied uniformly to the whole height of the wall below calm sea level, and reduced progressively above that level at the rate of two-thirds of the height. But account must also be taken of the supplementary shock which may possibly be exerted by waves which happen to break superficially by reason of wind action.

(v) The berm and outer slope of the rubble mound should be increased in width (from 10 m. to 15 m.) and flattened in slope (from 1 in 2 to 1 in 3) respectively as the structure is more exposed and the sea bed the more liable to disturbance.

In the case of a sea bed consisting of easily erodable material at no great depth the adoption of the vertical wall type of breakwater may entail the necessity, eventually prohibitive from the economic point of view, of protecting the bottom in front of the foot of the rubble mound over a considerable width by some suitable means such as a layer of rubble laid directly on the sea bed or on a mattress of facine work.

(vi) In the case of works of moderate exposure the wall may consist of bonded blocks of ordinary shape and dimensions. In the case of breakwaters in very exposed situations it is necessary to have recourse to units of much greater dimensions extending throughout the whole thickness of the wall, such as cyclopean blocks superposed, either in sloping bond or in vertical piers, or else consisting of monolithic sections formed of caissons of restricted length (measured on the centre line of the breakwater) and filled with concrete.

Such monolithic sections represent the best solution of the problem in regard to the stability of the wall. If, however, local circumstances are not favourable to this solution it is best to have recourse to a structure comprising piers of cyclopean blocks made into monoliths by filling suitable core or well holes with concrete, preferably reinforced by steel bars. In all cases if the piers are formed by the superposition of cyclopean blocks it is necessary to provide the horizontal joints between the blocks with a suitable packing either of lead or vegetable fibre.

Whatever may be the structure of the piers, it is necessary to unite them by means of the mass concrete superstructure, after time has elapsed for the settlement of the wall, especially in the case of a high rubble mound. Later on, when the construction is finished and further unequal settling of the mound is not to be feared, the wall should be made into a solid monolith by suitably filling all the joints between the vertical piers.

Note.

In the reconstruction of the Catania Mole and Mustapha Jetty, now being carried out, the original designs for vertical walls have been abandoned, as was mentioned in a leading article on page 221 of The Engineer of August 30th, 1935. At Algiers the form of the new work follows the classic Marseilles pattern of a wide rubble mound protected on the sea face by concrete blocks deposited pell-mell to form an outer slope brought up to the level of the top of the mass concrete superstructure. At Catania the mole is being rebuilt on a line inside the foundations of the ruined breakwater in the form of a rubble mound brought up to water level, protected on its sea face by large concrete blocks, and surmounted by a heavy mass concrete capping.

Signor Cagli, in his report to the Navigation Congress, which we have printed in an abridged form, does not describe or illustrate the designs adopted for the rebuilding of the Catania and Algiers breakwaters. Both are, however, referred to in other reports presented to the Congress. We reproduce from the report by Messieurs Benezit and Renaud a cross section of the Mustapha Jetty—Fig. 19—as it is now being rebuilt. Fig. 20 is a cross section of the reconstructed mole at Catania, for which we are indebted to Signor Cagli.

(To be continued.)

SIXTY YEARS AGO.

In a note in our issue of September 17th, 1875, we gave some brief particulars of a new form of locomotive which the inventor, Monsieur Fortin Hermann, had recently described to the French Academy of Sciences. The note is too condensed to permit us to recapture all the mechanical features of the design but the general outlines emerge clearly enough from it. The propulsion of the locomotive was effected by the rising and falling of six articulated feet which struck the ground or rails " something like the feet of a quadruped." These feet were arranged in two groups, three supporting the fore part and three the rear part of the locomotive. The two middle feet were connected together by a horizontal shaft. The others were independent and struck the ground successively " in such a manner that while the middle feet move at a moderate pace the others have a highly accelerated motion." The feet were driven towards the ground by steam power. Experiments conducted at Paris by the Eastern Railway Company had, it was stated, shown that when the feet were shod with soles of india rubber an adherence to the rails or road equal to three-fourths of the weight of the machine was obtained. It had been established, so it was reported, that the locomotive could drag on ordinary roads or on rails a train four times as heavy as an ordinary train. It was anticipated that with its increased adhesion the new design of locomotive could be made lighter than an ordinary engine on the same duty and that it would be capable of operating on steeper gradients than were usual on existing railways. With all due deference to Monsieur Hermann we had no hesitation, we said, in describing his steam donkey as a mechanical toy.... We might have added that the idea was not even new and that two years or so before the battle of Waterloo was fought a machine of—so far as we may now judge—exactly the design described by Monsieur Hermann was actually at work moving loads at Newbottle Colliery in this country. That machine was William Brunton's " walking horse " constructed at the Butterley Iropworks near Derby. In our issue of February 16th, 1912, we reproduced a portion of a letter written by the inventor to his brother John on April 28th, 1813, in which he described and illustrated the general arrangement and the details of the machine which he proposed to construct. Much of his attention was directed towards the form of the feet which were to make contact with the ground or rails. The use of rubber shoes was not proposed for rubber in those days was a scarcely known material. The first and only walking horse constructed in accordance with William Brunton's plans was built in the same year as that in which the letter was written. It was at work throughout the winter of 1814 and was so far successful that it succeeded in hauling loads up an incline of 1 in 36. Eventually the boiler exploded, killing thirteen persons. Following that disaster the inventor abandoned the idea.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

FLEXIBLE STEEL WIRE ROPE.

No. 5 W 2. A revised edition of the above-named specification has just been issued. The revision consists only in an amendment to the clause on marking the finished rope, each piece of which is now to be marked with the item number of the rope, in addition to the specification number. The opportunity has been taken of including in the specification the sizes of extra flexible ropes, which were agreed to in June, 1929, and hitherto issued as an Addendum to the Specification. Copes of this specification may be obtained at the price of 1s. 2d. post free.

CYANIDES SUITABLE FOR ELECTRO-PLATING.

No. 622—1935. This new Specification for Cyanides (Classes A and B) has been prepared by a technical committee representing the interests of both manufacturers and users, and whilst it was drawn up primarily for the electro-plating industry, it can be employed for any purpose, except that of gold refining. Particular attention has been given to the method of packing and storing, and there are useful warnings as to the handling of this highly poisonous material. In view of the failure of plating baths from various causes, the use of this specification, as well as that for nickel salts (B.S.S. No. 564) and nickel anodes (B.S.S. No. 558), recently issued, is specially recommended by the Institution.

Rail and Road.

THE Southern Company's new station at Tinsley Green, between Horley and Three Bridges, for the Gatwick airport, referred to herein on May 31st, will be opened for traffic on September 30th.

THE traffic receipts for the thirty-sixth week show that for the year, up to that date, there have been, when compared with the corresponding period of 1934, the following increases :—L.M.S., £480,000, or 1·16 per cent.; L.N.E., £75,000, or 0·25 per cent.; G.W., £132,000, or 0·76 per cent.; Southern, £127,000, or 0·89 per cent.

THE Confédération des Travailleurs Intellectuels has, in co-operation with the French Railways, again organised a travelling exhibition of pictures by living French artists. The exhibition was officially opened in Paris on Tuesday, September 17th, and is now making a tour of Normandy and the North of France, visiting some twenty-five prominent towns.

MONDAY, December 2nd, has now been fixed for the formal opening of the new pedestrian subways which have been constructed in front of the Monument Station by the City Corporation in collaboration with the London Transport Board. The Lord Mayor is to perform the opening ceremony and the Lord Chief Justice, Mr. Hore Belisha, Lord Ashfield, and Lord Snell are to be present.

THE Railway Staff Census, price 1s., for 1935, has now been published. It shows that on March 9th last the British railway companies employed 580,766 servants, as compared with 575,048 on March 10th, 1934. The total amount paid in salaries and wages during the year 1934 was £99,385,000, as compared with £96,557,000 in 1933. We would add that the census does not cover the men employed in the railway companies' locomotive, carriage, wagon, &c., shops, but only those engaged on the railway proper.

WORK is in active progress on the construction of a spur line near Glasnevin Cemetery, Dublin, to link up the Midland section of the Great Southern Railways with Amiens-street. This will enable Broadstone Station to be closed to rail traffic and used entirely as a bus depôt for the extensive omnibus department of the Great Southern Railways, which has resulted from the absorption at the end of 1933 by the railway company of the business of the Irish Omnibus Company, Ltd. At present, Broadstone Station is shared by road and rail vehicles.

AN accident that often, and quite justly, was quoted as an illustration of what the Sykes system of lock-and-block would avoid occurred on September 11th, 1880—fifty-five years ago—at Locomotive Junction, Nine Elms, London and South-Western Railway. A light engine arrived on the down line, which had then to set back into the engine shed yard. The time was about 10 p.m. and there were four signalmen and two booking boys in the box, who were changing duty. The result was that the engine was overlooked and a passenger train admitted. In the consequent collision five passengers and two servants were killed. On that occasion Major Marindin observed that it would be perfectly easy, by an adaptation of such a system of electrical interlocking as that in use upon the London, Chatham and Dover Railway and on the Metropolitan District, to make it impossible for a signalman, after having lowered the home signal for the light engine, to put that signal again to "clear" until the points had been set and the signal lowered for the engine to proceed to the shed and the siding points and their signal again put to normal.

SPEAKING recently before the Plymouth Rotary Club, Mr. Frank R. Potter, principal assistant to the superintendent of the line, Great Western Railway, said that that company was endeavouring to obtain from the Treasury financial assistance to carry out a number of important new works on all parts of the system. Of interest to his hearers, in the event of the programme being carried out, would be the reconstruction of North-road Station, Plymouth, which would then become a station worthy of that city. Penzance terminus would be improved and there was to be an avoiding line between Exeter and Newton Abbot. The scheme that appeals to us, because of its interesting features, is a proposed flying junction from the west end of the tunnel at Exeter Central, Southern Railway, station, over the Great Western main line at the south end of that company's St. David's station, to the west side of the G.W. lines and thence to the Southern's own lines to Plymouth at Cowley Junction. This scheme, which would have to have the co-operation of the Southern Company, would avoid the constant delays to the trains of both companies, *e.g.*, down trains of the Southern have to be kept back at the Central Station whilst anything is passing on either line at the junction on the G.W.R.

A HEAVILY-LADEN Sunday train for the Clyde steamers sailing from Gourock, on the morning of June 16th last, collided with the buffer stops at that station, but without serious injuries to any of the 700 or 800 passengers. The accident was inquired into by Major G. R. S. Wilson and his consequent report is the first he has written. It shows that additionally to the usual causes—unsuitable speed and incorrect application of the brake—there were other features that called for comment. The speed, when approaching the station, may have been as high as 25 m.p.h., instead of the 10 m.p.h. laid down. Major Wilson noticed, however, at his inquiry that there was a lack of strict observance of this rule, which "detracts from its value as a safeguard." The driver was not only guilty of misjudgment in the way he applied, then released, and afterwards re-applied the brake, but he "failed to realise the appreciable reduction in brake power that would be occasioned by the weight of a full load of passengers." The guard was unaware of anything abnormal as to the speed and by his lack of alertness did not give the driver the assistance to which the latter is entitled from his guard when entering a somewhat difficult terminal platform. The matter of most importance is that the driver's route card had the Gourock branch crossed out in red ink, which implied that he was not competent to work into that station. To Major Wilson, "it appears, therefore, that supervision of the rostering at Polmadie shed, in relation to knowledge of routes, was not altogether satisfactory." Active measures are now being taken to rectify this.

Miscellanea.

IN this country during August 28,000 new wireless licences were taken out, the total in force on August 31st being 7,175,116, compared with 6,428,961 a year ago.

WORK is shortly to be begun at the iron and steel works at Penistone, Yorks., which have been closed for five years, and which, as noted in THE ENGINEER some weeks ago, have been acquired by David Brown and Sons (Huddersfield), Ltd.

FOR the purpose of manufacturing reinforced concrete products for building and constructional work, a new company, Ferroconcrete (Lancashire), Ltd., is to open a works on the site of the recently closed Crown Copper Works at Liverpool.

PERMISSION has been given to the Lanarkshire County Council to proceed with certain new waterworks, pipe lines, and service reservoirs at a cost of some £200,000. Application has been made by the Council to the Commissioner for Special Areas in Scotland for a grant towards the cost.

IT has been decided by the Cardiff City Council to proceed with a scheme for a public hall, exhibition hall, and sports arena, which are to be erected by a London syndicate at an estimated cost of £250,000. The arena will have an area of 75,000 square feet and seating accommodation for 10,000, and will be used for all kinds of sporting events.

THE exhibition of the Coal Face Machinery Exhibitor's Association opens to-day at Bingley Hall, Birmingham. The first exhibition was held in Sheffield in 1931, when the total output of machine-cut coal was 76,864,037 tons and the tonnage mechanically conveyed was 47,307,535. The figures for 1934 were 103,700,000 tons of coal mechanically cut and 81,492,550 tons mechanically conveyed.

THE first section, consisting of sixteen signal installations, of the £40,000 experimental traffic light system in the borough of St. Marylebone was brought into operation on September 6th. The time allowed for the traffic to pass is fixed by a traffic integrator attached to the master controller at Marylebone-circus, according to the volume of traffic. Ultimately, there will be fifty-five road junctions in the district equipped with the system.

A COMPANY formed by three foreign banks has applied for a concession for the electrification of the Lodz industrial district in Poland. This foreign group would lay power cables, build transformer stations, and obtain the energy required from the electricity works at Lodz and Zgierz. It is estimated that the scheme would cost about £692,000. The company is prepared to purchase all the necessary building and installation material in Poland.

IT is announced that Sir Frank E. Smith, D.Sc., Sec. R.S., has accepted the invitation of the Council of the Junior Institution of Engineers to become President of the Institution for the 1935–36 session. He will be inducted by the retiring President, Mr. Clifford C. Paterson, M. Inst. C.E., M.I.E.E., at the inaugural meeting of the session, to be held at the Royal Society of Arts on Friday, December 13th, 1935, and will then deliver his address.

ACCORDING to the *Chemical Trade Journal*, negotiations are taking place for the sale of the L.M.S. electric power station at Clifton Junction, near Manchester. The company is now obtaining the necessary power from the Lancashire Electric Power Company. It is understood that the probable buyer is a firm which proposes to manufacture an alloy of metal largely composed of magnesium, which is to be used in the production of aircraft. The bulk of this material has formerly been made on the Continent.

IT is expected that the Wheeler Dam on the Tennessee River in the U.S.A. will be completed by September, 1936. The project has cost come 23 million dollars, and with an overall length of about 6400ft., this dam will be 1900ft. longer than Wilson Dam and 1340ft. longer than the Dnieper River hydro-electric and navigation undertaking in Russia. The dam is being built in a series of five cofferdams, built progressively out from the south shore at the head of the lake formed by the Wilson Dam, which crosses the river 15½ miles downstream.

DRIVING his new car, "Speed of the Wind," Captain G. E. T. Eyston has regained for this country the motor car speed records for one hour and 200 kiloms. He averaged a speed of 159·30 m.p.h. for the hour's run and covered 200 kiloms. at an average speed of 159·18 m.p.h. Assisted by his co-drivers, Mr. A. Denley and Flight-Lieut. C. S. Staniland, Capt. Eyston started at 11 p.m. on September 16th to break the world's twenty-four hour record. The attempt proved successful, the speed for the twenty-four hours averaging 140·19 m.p.h.

THE Tyneside Industrial Development Board announces that this year seven new businesses have been established in its area; two new factories are being constructed—one will open on October 1st—and work will begin on a third factory in the near future. In addition, eight businesses have either extended their premises or will do so in the next few months. These industrial developments are estimated to provide employment for an additional 1000 persons. Commander Sir Charles Craven, President of the Board, states that Vickers-Armstrongs' Elswick (Newcastle) works to-day employ 5500 people, against 3800 two years ago, and that at the Walker (Newcastle) naval yard 1000 are now employed, although the yard was closed two years ago.

A REPORT issued by the South Wales Coalfields Drainage Inquiry Committee stated that the commission of ten appointed to investigate the matter had recommended that the scheme of gravity drainage be not proceeded with at the present time. The commissioners had been influenced in their decision by considerable changes recently in the ownership of collieries. The scheme for draining the coalfields was put forward by Captain J. McLeod Carey, Inspector of Mines. He pointed out that there were large subterranean lakes containing many millions of gallons of water which had accumulated in the old workings of disused pits. These accumulations were a menace to the coalfields, he contended, for if they burst many valuable properties would be flooded, with possible great loss of life.

Air and Water.

THE Anchor liner "Cameronia," which has been laid up for a year, is to be reconditioned for the Atlantic passenger service.

THE new destroyer H.M.S. "Grafton," one of the eight destroyers authorised in the 1933 programme, was launched at Southampton on Wednesday last.

ONE of the largest trawlers ever built at Aberdeen, the "Viking," was recently launched. The vessel, which has been built for a French company, is 226ft. long, has a gross tonnage of 1200, and is designed to carry some 1300 tons.

Two of the thirteen balloons which left Warsaw on Sunday in the Gordon Bennett Cup contest have landed in Latvia and two in White Russia, about 100 miles on the Soviet side of the frontier. The nine others are believed to be over Soviet territory to the south of Moscow.

THE first of the two new passenger and cargo liners being built for the German African Lines will be ready for service in December, 1936, and her sister ship in March, 1937. Each of the vessels will be about 16,000 tons gross, propelled by steam turbines, and have accommodation for 500 passengers and a cargo capacity of 9000 tons.

THE Folkestone air trophy race was won on Saturday last by Mr. L. Lipton, flying a D.H. "Moth," at an average speed of 112 m.p.h. The race was on handicap and the second and third machines were a B.A. "Eagle" and a "Mew Gull." These machines covered the triangular course of 60 miles at an average speed of 140 m.p.h. and 198·5 m.p.h. respectively.

FURTHER to our announcement in the "Seven-day Journal" of last week, it is now reported that the Cunard White Star liner "Olympic," which was purchased by Sir John Jarvis for breaking up at Jarrow, has been acquired by Thos. W. Ward, Ltd. The vessel will be broken up at Palmer's Shipyard at Jarrow, which is now owned by Thos. W. Ward, Ltd.

THE L.M.S. Railway announces that new schedules for its London-Glasgow air service, which is operated on its behalf by Railway Air Services, Ltd., were brought into operation on Monday, September 16th. The northbound service now starts from Croydon Airport at 9.45 a.m. instead of 3.10 p.m., as previously, and arrives at Glasgow (Renfrew Aerodrome) at 2 p.m. instead of 7.30 p.m. The service in the reverse direction leaves Glasgow at 9.15 a.m. instead of 8.45 a.m. and arrives at Croydon at 1.30 p.m. instead of 1.5 p.m. The machines continue to call at Birmingham, Stoke-on-Trent (only on request), and Liverpool, where connections are given in both directions with the trunk services. The Manx Airway section between Manchester, Liverpool, and Blackpool and the Isle of Man, which is operated by Railway Air Services on behalf of the L.M.S. Railway and the I.O.M. Steam Packet Company jointly, will continue during the winter, with the exception that instead of six flights daily in each direction (Sundays included) there will only be two (Sundays excepted). Liverpool, instead of Manchester, will be the junction where connections to Birmingham and London and in the reverse direction will be given.

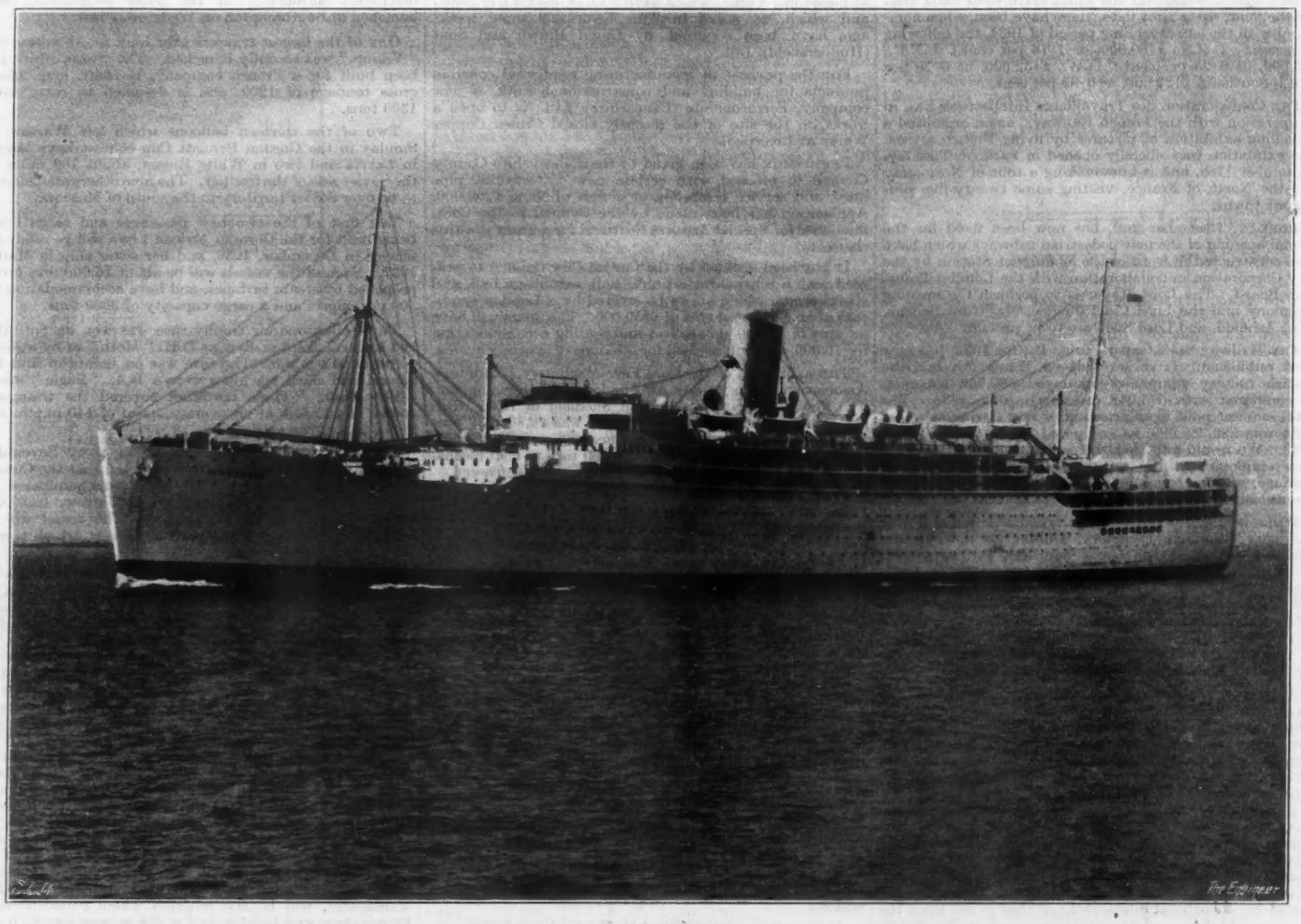
THE collision between the steamers "Napier Star" and "Laurentic," already referred to in our pages, provides an interesting example of the fact that a hull form which is designed specifically with the idea of improving a ship's performance may also serve the very useful purpose of minimising the results of a collision at sea. It is now generally agreed by the authorities and surveyors who examined the "Napier Star" and "Laurentic" that had the former steamer been fitted with her original bow and straight stem the damage to the "Laurentic" would have been very much more severe and probably, owing to the tremendous force of the impact, would have cut the "Laurentic" in two. The contact with the Maierform bow, however, forced this back gradually until the mass exposed brought the vessel to rest, and it is undoubtedly the gradual compression of the Maierform bow which minimised the effect of the collision. Whilst it is not claimed that the Maierform bow is completely exclusive in this connection, for any raking stem would have acted similarly to such an impact, there is no doubt that the peculiar properties of the bow in this particular collision exhibited qualities which are not usually taken into account by owners when considering new constructions or conversions.

DURING the past two years "Bristol" sleeve valve engines have been undergoing extensive flying tests in various types of aircraft, and the first units of this type delivered for actual commercial operation are four "Perseus II L" civil rated engines, purchased by the Air Ministry, and issued on loan, for installation in the Imperial Airways machine "Syrinx." Two of the four original "Jupiter X.F.B.M." engines were removed from this installation and were replaced by two "Perseus" engines. The "Perseus" civil rated engine is a nine-cylinder air-cooled radial, which develops a normal power of 640–665 b.h.p. at 2200 r.p.m., and a maximum power of 740–770 b.h.p. at 2525 r.p.m. On the regular runs between London and Paris the two new engines installed ran for 317 hours and 292 hours respectively. In accordance with the predetermined schedule to overhaul the engines at the conclusion of 300 hours' running, they were returned to the Bristol Company's works for complete dismantling and inspection. All parts were found to be in excellent order. In the meantime, the "Syrinx" has been installed with the two remaining "Perseus" engines and, with the original two "Jupiter" engines, and the tests are being conducted under similar conditions. With two "Jupiter X.F.B.M." and two "Perseus" sleeve valve engines the cruising speed of the "Syrinx" was increased by 8 m.p.h. and the fuel consumption considerably reduced as compared with the original four "Jupiter" engine installation. Because of the conflicting optimum speeds of the two kinds of engines, however, it was not possible to operate at the maximum efficiency. When the "Syrinx" is completely equipped with four "Perseus" engines conditions will be on a truer comparative basis, and performance figures are expected to improve very materially.

THE NEW 23,500-TON P. AND O. LINER "STRATHMORE"

VICKERS-ARMSTRONGS, LTD., BARROW-IN-FURNESS, BUILDERS AND ENGINEERS

(*For description see page 289.*)



ABOVE:—THE NEW LINER ON HER TRIAL TRIP
BELOW:—A VIEW IN THE ENGINE-ROOM

The Engineer

SEPTEMBER 20, 1935.

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THE EXHIBITION.

WE have no hesitation in saying that the present Exhibition at Olympia is the best of the long series which that veteran, Mr. F. W. Bridges, has organised. Its two predecessors, and particularly that of 1933, left something to be desired, not because the organisation was lacking, but because the engineering and allied industries were in a poor state. The wealth of material exhibited and the general atmosphere of the present display is sound evidence of the better health of those industries and of the revival of courage and enterprise which is accompanying it. Olympia differs from Castle Bromwich in a notable respect. Without decrying for a single moment the value and importance of the British Industries Fair, it cannot be said that it approaches being representative of the great industries associated with engineering. It deals with no more than a few sections, of them; not with the whole. At Olympia, on the other hand, whilst there are omissions, so many aspects are represented that a foreign visitor may gain there a fair impression of the varied potentialities of British engineering. The most notable omission is, as usual, the machine tool, but, owing to the fact that a few makers are outside the Machine Tool Trades' Association, the industry is represented by several examples. There may be set against this omission the display, a very remarkable one, organised by the Foundry Trades' Equipment and Supplies Association, Ltd. It may be safely claimed that no country in the world has given greater attention to the science of metallurgy and its applications than Great Britain, and the inclusion at Olympia of a section which indicates the development of foundry practice rounds off, as it were, the whole Exhibition. It is greatly to be hoped that this section may become a permanent feature.

The period which has elapsed since the last Exhibition has been one of recovery from the depression rather than of very notable technical advances. The past two years have not produced, in the realm of engineering, any remarkable new inventions, but they have seen progress and development of design. Visitors may be advised to examine, for example, the many types and sizes of internal combustion engines which are staged and to admire the cleanness of design which they show. With the improvement of trade, the return of confidence which it induces, and the money which it provides, we shall, we hope, see more evidence of new inventions at the Exhibition two years hence. Nothing could do more to remove the spectre of unemployment than the origination of a new industry in our midst. Even a very summary glance through the pages of industrial history shows that the really great increases of employment result, not from the development of established industries so much as from the introduction of new. Throwing the mind back over no more than forty years or so, and omitting therefore the vast electrical industry, consider the rapid rise of the safety bicycle, the motor car, the rayon, and the plastics industries. Each of these has reacted upon others, and it is quite impossible to estimate their total value to the country, but it is probable that the annual monetary turnover of the four that we have named alone approaches two hundred millions of pounds sterling. Wireless, a relatively new industry, has a turnover already in the neighbourhood of twenty-five million pounds, and it is not improbable that in a few years television will be able to record a turnover approaching half that figure. Last year the two leading firms in the bicycle industry made no less than one million machines and gave direct employment to six thousand persons. In the same period, 257,000 cars were made in the United Kingdom and it is estimated that that industry finds employment for half a million people. In the rayon industry of the kingdom, 25,000 persons are directly employed and the invested capital reaches the enormous figure of £150,000,000. The estimated world output of rayon for the current year is 800,000,000 lb. The output of complete wireless sets in this country last year reached the astonishing figure of fifteen million, and if equivalent equipments were included twenty-three million. These figures are all drawn from industries new within the memory of even young men. If another one comparable with them in size can be found, even the estimated unemployable million in this country may be absorbed. The fact that no one can visualise such an industry does not mean that it will not come, though it may show that its advent is not imminent. No one, we suggest, could have foreseen the extraordinarily rapid rise of bicycling, few imagined the position that motoring would acquire ten years after its beginnings, and not even Marconi himself would have ventured to forecast the astonishingly rapid rise of broadcasting. But it is true that these things had their adumbration, they cast shadows—weak and ill-defined—before them. It may therefore be that no new industry is at hand, but at any day the first hints of its coming may reach us. Our readers may be surprised that amongst modern industries we have not especially mentioned the marine internal combustion engine, not yet twenty-five years of age. It will, however, be granted on consideration that it has taken away almost as much as it has added. Had it not come, the steam marine engine would have continued to advance. We agree that for smaller sizes the marine internal combustion engine has added to the volume of work performed, but it is, manifestly, not to be compared in that respect to a new industry, the cycle industry, for example, which added a new quantity without taking anything from an old one. That is what we want now, and who knows but that we may see the first signs of it before the next Shipping, Engineering, and Machinery Exhibition is opened in Olympia.

We have spoken of the better and happier atmosphere which is shown at the Exhibition in consequence of the better tone of the engineering industries. An example was given at the luncheon which followed the official opening by Lord Sempill. Speaking at that luncheon, the Master Cutler, Mr. A. Williamson, gave a few very remarkable figures about the progress of the steel trade. He said that as compared with 1932 steel makers had now an output 82 per cent. greater, and that employment had increased by over 40 per cent. He added that the price level of iron and steel products, as computed by the Board of Trade from twenty-six different items, is barely 1 per cent. higher than in 1930. A few days later the figures for the overseas trade for August were published. They show that goods to the value of nearly £35,000,000 more were exported last month than in the corresponding period of last year; and that for the eight months of the year an increase of nearly 9 per cent. on last year has been attained. With the material progress that such figures indicate, and with the courage and hopefulness that they inspire, we look for a still more rapid advance of our engineering industries in the coming two years, and we pray that no cataclysmal event may occur to shatter the brighter prospect which is opening before us and before the world.

The Rating of Water Power.

THE issue by the British Standards Institution of a specification whose application is intended to be international is, we believe, an innovation in the practice of that useful body. The recently published British Standard Specification for the Rating of Rivers for Power Purposes owes its inception to somewhat peculiar circumstances. As far back as 1925 the International Executive Council of the World Power Conference, at the suggestion of the Canadian National Committee, considered the adoption of an international standard for the measurement of water power. A good deal of preliminary work was carried out during the years immediately following, and in 1928 the International Electrotechnical Commission, at the request of the World Power Conference, set up a committee "to make recommendations, for international acceptance, regarding the bases for computing, and the units for expressing, water power resources for statistical use and for the purpose of making comparisons between different rivers, river basins, regions, and countries." All the material previously collected by the World Power Conference through its National Committees, particularly those of Canada, Switzerland, and Sweden, was passed over to the new committee, which, under the chairmanship of Mr. N. C. Grover, of the United States, presented its report at the plenary meeting of the International Electrotechnical Commission held at Stockholm in 1930 and its recommendations were approved and adopted by that body. These recommendations have now been embodied in a British Standard Specification.

The desirability of such a specification for international use and application must be obvious to all who have occasion to make statistical comparisons of water power resources and development in different countries. In arriving at an international solution of the problem of the rating of rivers it was considered desirable, and even necessary, to reduce each component of the problem to its simplest terms, and for the guidance of those who may have occasion to use the specification, the principles on which the recommended methods of computation are based are fully set out in a foreword and an appendix to the document. The difficulty of comparison is increased by widely varying circumstances. Climatic conditions in various parts of the world range from humid to arid, and from sub-tropical to temperate and even frigid, some basins being snowbound for several months in the year, and some containing glaciers. In addition, the peculiar class of basin which is confined to tropical "monsoon" countries, where there is neither rainfall nor stream for the greater part of the year, but where a vast body of water comes down during the short wet season, must be taken into account. Such a basin can only be developed by storage pure and simple, and therefore only where reservoir sites of sufficient capacity exist. Account must also be taken of the fact, emphasised in the foreword, that "while complete records are often obtainable where there is a prospect of development, there are also vast regions in which, for the time being, there is no prospect of any gaugings whatever being made; and other regions in which the most that can be hoped for is an occasional isolated estimate of the rate of flow. Rating in such cases is largely a matter of intelligent guesswork, for which it is not possible to lay down rules." The specification contains definitions of terms and units, rate of flow being expressed in cusecs and head in feet; but a note is appended that the recommendations of the International Electrotechnical Commission provide for the alternative use of the metric equivalents, cubic metres per second and metres. A distinction is drawn between natural rate of flow and additional rate of flow due to storage, the rating being based on the combined values of these rates of flow. Formerly the practice in different countries in "rating" the flow of a river showed considerable variations. In Canada the "ordinary six months' flow" has been used as a basis of one of the ratings and is defined as the average of the flow of the seven consecutive days of lowest flow of month No. 7 of a table in which the months of the year are arranged in order, according to the lowest daily flow; No. 1 being the month of lowest flow and No. 7 being the lowest of the six highest months. In the United States of America the Q50 flow had

been adopted as a basis of one of the ratings. The Canadian six months' flow averages about 15 per cent. less than the Q50 flow, and is about the same as the Q60 flow. The three ratings adopted as standard in the specification are based on three values of the combined natural and storage rates of flow, referable to the duration curve of the river, viz.:—(i) Low rating, based on ordinary minimum flow, defined as the natural or present flow available 95 per cent. of the time, or approximate equivalent, with a statement as to the month of occurrence of the low flow (this is the Q95 flow of the duration curve); (ii) middle rating, based on medium flow, defined as the natural or present flow available 60 per cent. of the time or approximate equivalent (this is the Q60 flow of the duration curve); and (iii) average rating, based on the arithmetical mean flow. For the purpose of computing available power it is recommended that the rating of any stretch of river capable of being developed for power shall be based on the gross head (as defined in the specification) and on the full accepted value of the rate of flow of that stretch, *i.e.*, the full theoretical power in that stretch shall be expressed in kilowatts at 100 per cent. efficiency, without deduction for losses in development.

It is in connection with the bases of rating that this specification is of importance and should be of international value. Although the present methods of assessment of water power may vary, experts from a dozen countries, having before them the full data of a stretch of river, and using the recommendations given in the specification, should be able to agree within narrow limits as to the practical value of the normal and maximum economic ratings.

The British Association.

No II.

(*Continued from page 271, September 13th.*)

Diesel Engines and Coastal Shipping.

ON Friday, September 6th, Dr. S. J. Davies delivered an evening discourse in the Agricultural Hall Assembly Room, Norwich, on the applications of oil engines to coastal shipping.

He confined his subject to tugs, fishing vessels, and coasters. The conditions under which the machinery of coastal vessels worked, he said, were most exacting, and it was impossible to provide the careful attention in service usual in larger ocean-going craft. The machinery, therefore, had to be designed to meet those conditions, and everything possible had to be done to lighten the duties of the engineer, and to facilitate the repair or renewal of those engine parts that must inevitably wear out in service. The present time might still be regarded as experimental so far as the design of Diesel engines for coasters was concerned. Many firms were entering or attempting to enter the field, and it was obviously desirable for advantage to be taken of this competition. But the full benefits of the Diesel engine could not possibly be realised until that point in the development was reached when a limited number of designs could be standardised.

Recent investigations into the wear of cylinder liners had demonstrated the bad effects of changes of temperature of the circulating water, and in particular of running an engine with cold circulating water. Coastal vessels, with their rapid changes of load and speed and relatively frequent stops, were especially subjected to such unfavourable conditions, and it would be sound economy on all but the smallest vessels to take steps to reduce their effects. Again, coastal vessels operated for a large part of their time in dirty river water, while, when outside, the sea water was corrosive. To ensure efficient cooling of the engine cylinders, cooling, in all but the smallest vessels, should be by fresh water passing around a closed circuit consisting of a small header tank well above the engine feeding into the line near the pump suction, and a tubular cooler placed well down in the vessel. To guard against the effects of temperature changes, a by-pass valve, operated by a bellows thermostat, could be fitted into the circuit to ensure that once the engine was warmed up the temperature of the jacket water would be generally independent of the load on the engine.

Having given a brief description of the equipment of a tug, Dr. Davies said that whilst companies were naturally reluctant to publish full data concerning their operating conditions, the Thames Steam Tug and Lighterage Company, through their superintendent engineer, Mr. F. J. Mayor, had been kind enough to give him the following figures, which enabled a sound comparison to be made between a steam tug and a motor tug under given conditions of service :—

	Motor tug.	Steam tug.
Fuel and oil	18·7	49·0
Repairs	24·4	24·2
Capital charges	34·6	5·5 (17·3)
Personnel	16·6	21·3
	94·3	100 (111·8)

Saving per tide, 5·7 per cent. on *actual* total charges; saving per tide, 15·7 per cent. on *corrected* total charges.

From those figures it was seen that the saving with the motor tug per tide was 5·7 per cent. of the total charges with the steam tug. That figure, however, was unnecessarily biassed in favour of the steam tug, and 15·7 per cent. appeared to be more near to the correct saving. The power of the motor tug was 340 b.h.p., and that of the steam tug 250 b.h.p., so that the fuel and capital charges were proportionately lower. The fuel used in the motor tug was ordinary Diesel oil of s.g. 0·86–0·87 at 60s. per ton, which, for the first three years of the five years' working, had cost 67s. 6d. per ton, and best quality lubricating oil was used. The cost of coal for the steam tug averaged 30s. per ton. Certain troubles were experienced with the Diesel engines in the first place, but they were quickly overcome. The cylinders were not provided with liners, and after 3½ years it was necessary to regrind them and fit new oversize pistons. The whole of those expenses was charged to repairs. With the initial difficulties overcome, however, it was reasonable to expect that the charges for repairs during the second five years of service would be appreciably lower than those of the first five years. There were other incidental advantages connected with the motor tug which could not be directly stated in figures, *e.g.*, the saving in fuelling time with oil as compared with coal, and the great increase in the radius of action as compared with the steam tug. The reduction of time for "making ready" was also a factor of importance, four hours from banked fires for the steam tug, against a liberal allowance of one hour for the motor tug. The motor tug was cleaner, and, although of minor importance, that involved a complete absence of substances which might adversely affect the hull structure; with the steam tug the quenching of the fires with water caused various harmful substances to flow into the bilges.

The other two types of coastal vessels to be considered were the coaster, intended to afford accommodation for cargo and sometimes for passengers, and the fishing vessel.

In connection with drifters and small trawlers, the adoption of Diesel engines had been very uneven at the various ports around the coast. The Cornish fishermen, for example, had applied small engines to practically all their small sailing ships, a practice which was being extended everywhere to inshore vessels. The Scottish fishermen had gone farther and had applied Diesel engines to many vessels of the sizes formerly steam-driven. For the largest vessels, reversing engines with direct drive to the propeller were usual; for small vessels, combined speed-reduction and reversing gears gave the best service. The engines of the latter could run at much higher speeds of revolution, thus reducing their weight and initial costs, and some speed reduction to the propeller was essential for reasonable propeller efficiency. In the intermediate classes the question at issue was—up to what size of engine may the arrangements for reversing and for speed reduction, used on small vessels, be extended from the points of view of mechanical reliability, running efficiency, and first cost?

Consideration was then given to methods of driving the winch on fishing vessels, and the cheapness, robustness, and reliability of the steam-driven winch were emphasised. The type of winch drive, however, which did not appear to have received sufficient attention, continued Dr. Davies, was that of low-pressure compressed air at, say, 60 lb. per square inch. That neglect was all the more surprising when it was remembered that the standard steam winch engine would, without change, work with compressed air. A high-speed Diesel air compressor set, such as was commonly used in road-making operations, could deliver air as hot as possible to a lagged reservoir on deck, from which the winch engine would take its air as required. Additional heating of the reservoir could readily be arranged. As regarded efficiency, the overall value of air compressor and winch engine would easily be superior to that of the steam winch, which, whatever its other virtues, certainly did not show a high thermal efficiency.

Taking for granted the reliability of Diesel engines in service, it was pointed out that other factors must be taken into account in making a comparison between steam engines and Diesel engines, and since the first costs of the latter were higher than those of the former, Diesel engines must show other advantages to counterbalance their higher capital charges. These compensating advantages followed mainly from two important facts, first, for the same power output Diesel engines occupied considerably less space than the corresponding steam engines and boilers, and secondly, the Diesel engine had a much higher thermal efficiency than the steam engine, not only at full output, but even more markedly at reduced outputs.

Few data for direct comparison of steam and Diesel vessels were yet available, but such figures as existed showed a very considerable difference in the cost of fuel, and in one comparison between a steam drifter and a motor drifter engaged in 1934 in herring fishing, the balance of receipts over expenses—not to be confused with profit—was £381 for the motor vessel, against £232 for the steam vessel. The details are set out below :—

Comparison between Steam and Motor Drifter for the Yarmouth Herring Fishing, 1934.

Steam drifter, proceeds. Sale of herrings, £548 0s. 8d.				Motor drifter, proceeds. Sale of herrings, £541 3s. 8d.			
Expenses.	£	s.	d.	Expenses.	£	s.	d.
Commission	23	7	8		25	7	5
Harbour dues	15	14	9		10	4	2
Water-baskets and salt	21	8	0		1	13	6
Fuel	112	6	3		38	15	0
Engine-room stores	11	0	6		10	14	8
Engineer's wages	27	0	0		—		
Fireman's wages	21	12	2		—		
Cook's wages	20	5	6		20	5	6
Insurance (crew)	4	14	6	Crew & gear	8	15	1
Cutch and carting	8	9	6		4	10	0
Extra man	16	6	6		—		
Food	32	17	5		39	4	10
Total	315	2	9		159	10	2
Receipts	548	0	8		541	3	8
Expenses	315	2	9		159	10	2
Balance	232	17	11		381	13	6

There was, however, a class of coasting service where the lower capital charges of steam engines might justify their retention, namely, where the vessel took a series of relatively very short trips and spent the greater part of its time loading and unloading. In that case, if coal were cheap, the lower fuel costs of the Diesel engine would not be sufficiently marked to outweigh its higher capital charges.

One question would surely exercise the minds of those who had our mining industry at heart, namely, the further decrease in the direct consumption of coal involved in the change from steam engines to Diesel engines using imported fuel. It was clear, however, that a balance must be struck between the imported fuel and the home-produced fuel, and the answer to the question concerning the mining industry was that all encouragement and support, financial, and political, should be given to those engaged in the production of liquid fuels from coal.

Finally, Dr. Davies again emphasised that the design of Diesel engines for small powers is still in the experimental and strictly competitive stage. The engine builder who could simplify and standardise his product had a great opportunity, but he must also realise the need for a proper repair and spares service, permitting cheap and ready replacement of worn parts, such as bearings, &c., and in this connection he might well study the progress in the automobile industry which had accompanied the change from hand methods to interchangeable manufacture.

In Section G, three papers of electrical interest were read simultaneously with the discussion on lubrication which Section G was taking part in with Section A (Mathematical and Physical Sciences) on Monday, September 9th.

Dielectrics at High Frequency.

The first paper was by Dr. B. A. Sharpe and Mr. B. J. O'Kane, who dealt with the properties of dielectrics at high frequencies. This work was carried out at Liverpool University under the general supervision of Professor E. W. Marchant. The authors point out that they have made measurements of the electrical properties of a wide range of dielectrics and that the results show the variation of permittivity and power factor with both frequency and temperature. The frequency range used was from 10^4 to 10^7 cycles per second, the measurements being made by the method of substitution in a resonant circuit. The temperature range was from atmosphere—about 17 deg. Cent.—to 110 deg. Cent., the sample, electrode clamps, &c., being contained in an oven. The results show that below 250,000 cycles per second, a conductivity effect is the predominant factor in determining the shape of the power factor-frequency curves, whilst above that frequency the shape of the curves is governed by the effect of the permanently polarised molecules present in the material. The samples used were porcelain, plate glass, Pyrex glass, tulip-wood, tulip-wood paper, tulip-wood paper varnished with shellac, pure rubber, vulcanised hard rubber, ebonite, Pernax, Paxolin, and red fibre. All the samples except the paper were in sheet form about 6in. square by $\frac{3}{16}$in. in thickness. The paper samples were made up of twelve sheets 5 mils in thickness. These were placed in the electrode clamp and left until the capacity reached a steady state. The samples were conditioned by keeping them at a temperature of 110 deg. Cent. for a day and allowing them to cool in a desiccator. The red fibre was allowed to soak in water for twenty-four hours so that it would absorb the maximum amount of moisture. It was then gradually dried until all the moisture had been driven out. The amount of moisture in the fibre was determined by the difference

between the final weight of the dry fibre and the weight after each drying. The paper contains full illustrated details of the experimental methods employed together with a large number of curves giving the results.

The paper was introduced by Professor E. W. Marchant, who spoke of the importance of the properties of dielectrics at very high frequencies in connection with television, in which, as was mentioned in the lecture by Captain West on Friday, September 6th, wavelengths of 8 m. or less are now being employed. The fact that little was known of the properties of materials at those frequencies had led him to suggest to Dr. Sharpe a few years ago that some experiments should be carried out on permittivity and losses in condensers at such frequencies. The difficulty of finding an oscillator to generate the required frequencies with sufficient power had eventually been overcome, but the difficulties of making measurements at the frequencies involved still remained. Nevertheless, notwithstanding the difficulties of measuring voltages of 10^7 cycles, Dr. Sharpe had designed a high-frequency volt meter of a simple form in which there was a suspended rod about 2in. long with a sphere at each end. These two spheres were each located inside a ring, the two rings being electrically connected to form one pole of the instrument, the rod and spheres forming the other pole. The capacity of the instrument was about $2\,\mu\mu$F., and it had a frequency of 10^7 cycles per second at a voltage of 500, the current being about 0·6 ampères. It was found, however, that it was necessary to employ a mercury contact owing to this current being too heavy for the suspension filament. A simple substitution method had proved more satisfactory for measuring the power losses than electrostatic watt meters and bridge methods

Professor W. Cramp stressed the importance of the application of the subject not only for telegraph and telephone cables, but also in connection with condenser design, and pointed out how, in the case of cables, the greater the permittivity the worse the cable, which was, of course, in the opposite sense in which that research had been applied. If that paper indicated to manufacturers the best materials to use to obtain high permittivity for condensers and small permittivity for cables, it would be of very considerable value. Commenting on one or two details concerning the research, Professor Cramp suggested that the use of the method of substitution might make it difficult to be quite certain of the resistance of the wires, and his own experience led him to believe that mercury contacts should be avoided as far as possible. Emphasising that permittivity must be affected by the thickness of the dielectric, Professor Cramp suggested that whilst the curves obtained by the authors could be regarded as a general guide, he doubted if they actually represented the specific values that could be accorded to the material. He concluded by remarking that the tests on fibre with various moisture contents were more of academic interest than otherwise, because to-day manufacturers did not employ fibre and, indeed, laid themselves out not to do so.

Professor F. G. Baily, referring to contacts made with vaseline and tin foil, said he had found that the pressure applied made an enormous difference and in the case of his own particular work vaseline would have been useless. Mercury contacts had been found to be a little better. At the high pressures used by the authors, the merest film of vaseline might have a considerable effect upon the power factor.

Professor Marchant remarked that a large number of experiments had been made comparing tin foil and vaseline with mercury, and the results led to the conclusion that tin foil and vaseline were the better.

Professor Baily, in the course of a few further remarks, disagreed with Professor Cramp's views with regard to fibre, and said that although it might not be a good substance from the electrical point of view, it was mechanically very strong and was used by many manufacturers for that reason where its hygroscopic properties did not have any great influence.

Professor L. S. Palmer remarked that little had been said by the authors with regard to the difficulties of measuring at frequencies corresponding to a wavelength of, say, 3 m., and also inquired what steps had been taken to calculate the volume of the material, pointing out at the same time the importance of edge effect. Information concerning the breakdown of the dielectric was also asked for.

Professor G. W. O. Howe expressed the view that round wires were the ideal form of resistance, because the cylindrical form was the only one which permitted of calculation. At the same time, he pointed to possible effects upon the cylindrical form due to the scraping that was necessary. The problem, he continued, could be attacked either from the point of view of the manufacturer using the materials employed in practice, as had been done by the authors, or by using very carefully selected and even synthetic products. There was one class of dielectric material, namely, ceramic, which had not been mentioned by the authors, but upon which much work had been done in Germany, where the investigators had obtained enormous permittivity. Moreover, with such substances he believed a material with a specific permittivity could be obtained as desired.

Professor Marchant briefly replied to the discussion, and first pointed out that the materials used in the investigations had been supplied by a firm of cable manufacturers. He commented upon the difficulties associated with the resistances used in the substitutional method, and added that manganin wire seemed to be the only practicable form. At the same time, he did not wish to stress the accuracy of the results obtained, having in view that materials differed among themselves. Whilst agreeing that mercury contacts were far from perfect, he pointed out that a contact between mercury and amalgamated copper had a very low resistance if it were kept clean. In reply to the comments upon the use of tin foil and vaseline, he said the authors had carried out a large number of tests with different materials, but found that tin foil and vaseline gave results almost equivalent to those obtained with mercury. He added in conclusion that not only was it hoped to make some investigation on ceramic materials later, but that a certain amount of work had already been done on three organic acids, although the paper did not refer to it.

Surges in Transmission Lines.

The second paper was by Dr. J. L. Miller, of Ferranti Ltd., and was entitled "Surges in Transmission Lines and Transformers."

Dr. Miller started his paper with a brief review of progress and pointed out that as the result of large-scale research it had been established during the last eight years—with the aid of the klydonograph, the Dufour high-speed cathode ray oscillograph for the automatic measurement of single transients, and the surge crest ammeter—that surges due to switching operations and arcing grounds were unimportant and that the only dangerous over-voltages arose from lightning. Further, only direct lightning strokes closing on the line conductors, tower or ground wires had been considered, as induced surges only assumed importance on low-voltage lines. Indication of the importance of the lightning question on the scores both of operating and breakdown troubles was given in the mention of the fact that 13 per cent. of the papers published in the "Transactions" of the American Institute of Electrical Engineers during the past two years have dealt with some aspect of the lightning problem and that 85 per cent. of lines in America have some form of lightning protection.

Since the realisation of the importance of direct strokes, both mathematical and field research had been directed towards a proper understanding of the phenomena, and investigators had met with a certain amount of success. Thus with modern designs a reduction in lightning troubles for lines of all voltages, compared with those of a few years ago, could be obtained although only by the entailing of considerable extra expense. It appeared that with present-day constructions and precautions very high-voltage lines—of the order of 220 kV—could expect a certain measure of immunity, but that normally insulated lines of 132 kV downwards were still liable to a considerable amount of trouble.

The explanation of the partial failure of ground wires to afford protection was to be found in two characteristics of the lightning stroke itself, viz., the relatively large current in the stroke and the rapid rate of voltage rise. With currents of the order of 50,000 ampères—which were quite common—and extreme values of 250,000 or 500,000 ampères, flowing in a striken tower, an earth resistance of a few ohms might give sufficient volt drop between the tower top and the earth plane to cause flash-over from the tower across an insulator string to a phase of the line. Further, since the voltage across the insulators was, on that assumption, a function only of the earth resistance and the tower current, flash-over was more likely to occur on a 66-kV or 132-kV line than on a 220-kV line. To reduce as far as possible the danger of such flash-over from the tower it was necessary to obtain very low values of the earth resistance or to make use of counterpoises where low values of the earth resistance were impossible owing to unsuitable soil conditions. The rate of rise of voltage in a lightning discharge at a stricken point was not yet known, but it was reasoned that particularly on medium-voltage lines many flash-overs might be initiated by breakdown across an insulator string before the return of the reflected wave from the tower foot by reason of a rate of increase of lightning voltage of the order of several thousand kilovolts per micro-second.

Speaking of a stroke to a ground wire at mid-span, as distinct from strokes to a tower or to a ground wire near a tower, it was pointed out that danger could be averted to a great extent by expediting the arrival of the reflections from other tower tops by the use of short spans and also by increasing the height of the ground wires above the line. Both devices, however, were expensive and the latter had the further disadvantage that the system was then open to a greater number of direct hits.

Commenting on the use of the de-ion gap to overcome the poor service performance resulting from frequent circuit breaker operation occasioned by the power frequency follow-up current, Dr. Miller remarked that although they have been used with satisfactory results it had been stated, as the result of experience, that the tubes required considerable maintenance and it appeared that they did not yet provide a complete panacea of insulator flash-over troubles.

The influence of direct strokes and flash-overs on line behaviour both from the point of view of power frequency follow-up current and the propagation of travelling waves was then considered, and the effects of the latter, together with those of direct strokes to shielded and unshielded sub-stations was discussed in relation to internal stresses in transformer windings, it being pointed out that the most severe are axial stresses due to rapid voltage collapse or rise.

Some remarks were next made on non-resonating transformers and also the impracticability, due to the different characteristics of air and solid insulation, of satisfactorily employing rod gaps for insulation co-ordination purposes. Both the sphere and the rod gap, not possessing any de-ionising properties, had the disadvantage that their operation might—depending only on the flash-over approximately coinciding with a power frequency voltage crest—be followed by a power arc, tripping of the breakers, and shut down of the system. The de-ion gap did not show that disadvantage, having the property of quenching the power frequency follow-up. The problem of complete co-ordination of line and transformer insulation was complicated by reason of the entirely different surge characteristics of the insulation and of the gaps used to safeguard it. If complete reliability of the normal transformer was required, then from a knowledge of its insulation strength the co-ordinating gaps must be set at a low level such that the stress resulting from the steepest over-voltages was limited to the flat part of the curve where the insulation life was indefinitely great.

The Specification of Magnetic Qualities.

Dr. L. G. A. Sims, of the Electrical Department, Birmingham University, presented the final paper. In it he discussed the need for agreement in the specification of magnetic qualities, with particular reference to incremental magnetisation. He directed attention to the problem of arriving at an agreed method of measuring the incremental magnetic qualities of sheet steel, both as an aid to designers of the apparatus concerned and in order that the merits of different steels might be compared upon a common basis.

It was pointed out that, owing chiefly to demands of various branches of the wireless industry, large quantities of magnetic sheet steel were required for operation under incremental magnetisation, *i.e.*, under combined A.C. and D.C. magnetisation. As examples, Dr. Sims mentioned microphone transformers, audio-frequency potential transformers (interstage transformers), audio-frequency power transformers (output stage transformers), supply frequency power transformers feeding rectifiers and supply frequency smoothing chokes. In the latter two cases, he said, the size and weight of the apparatus might be comparable with those of the large 50-cycle transformers of the electric power supply industry.

Approaching the subject *viâ* the specifications already established for the testing of magnetic sheet steels intended for the older industrial applications, as, for example, the D.C. machine and the transformer as built for power and lighting, he said that at least four important specifications for such non-incremental applications existed, *i.e.*, the British, French, German, and American, the most recent being the British. They were all directed towards the testing of iron to operate under steady-state conditions, as in D.C. work, or under alternating magnetisation, as in A.C. work, and they did not include magnetisation by combined A.C. and D.C. That case offered difficulties, and he mentioned particularly that the correlation of A.C. and ballistic test methods of measuring incremental permeability was not generally possible owing to unsymmetrical wave form distortion introduced by even harmonics.

The two measurements chiefly of importance, said the author, were those if iron loss and permeability. Discussing tables showing the main details of the four specifications mentioned, he selected for discussion only the agreed methods of measuring iron loss and permeability. The tables showed that the measurement of iron loss was to be made with sinusoidal induction or at least with a sine wave form factor, and that permeability was to be measured ballistically (though the German specification also permitted an alternating current method of measurement).

In establishing an agreed procedure or specification for incremental work it would seem desirable to conform where possible with the established specifications. In them the adoption of sinusoidal induction change in the loss test and ballistic measurements in the permeability test were not at variance, due to the symmetrical hysteresis loop. But in the incremental case that was not so.

Retention of the ballistic test for incremental permeability might be considered necessary in order to eliminate eddy current effects. If so, the results obtained could, in general, compare only with true combined D.C. and A.C. excitation if the A.C. component of the exciting current was sinusoidal. That meant non-sinusoidal induction and applied A.C. voltage.

The author expressed the hope that agreement might be reached upon the best compromise to adopt. Not only would that be useful to industry, but it would also facilitate research, for the research worker in certain branches of incremental magnetism was handicapped by the lack of an agreed method of measurement.

(*To be continued.*)

The Shipping, Engineering and Machinery Exhibition at Olympia.

No. II.

(*Continued from page 265, September 13th.*)

THE FLEXTOL ENGINEERING COMPANY, LTD.

A VARIETY of light power-driven hand tools is demonstrated by the Flextol Engineering Company, Ltd., of 112, Grosvenor-road, London, S.W.1, to some of which we have previously referred. They are all, as is suggested by the name of the company, intended to be driven by an electric motor, or other convenient means, through a flexible shaft. In this way the operator is saved from the fatigue of carrying the weight of an electric or pneumatic motor at the working point which is otherwise entailed.

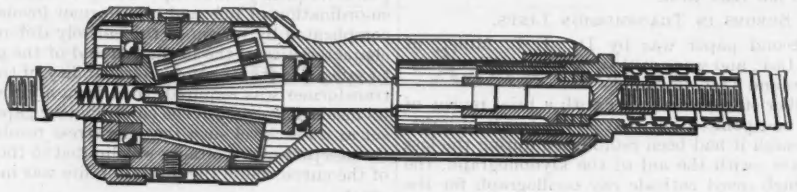

FIG. 10—HANDPIECE OF FLEXIBLE SHAFT-DRIVEN TOOL—FLEXTOL

It is with the working end that the company is chiefly concerned, and the flexible shaft and driving motor can be taken as standard practice. There is, however, a wide variety of handpieces available. That shown in Fig. 10, for instance, provides a rotary drive with a clutch action and a variable speed within limits. The drive is transmitted through a sun and planet system formed of tapered rollers. The approximate gear ratio is 5 to 1, but can be varied within limits by pressing the sun roller further down between the planets, against the action of a spring, as the tool is fed into the work. When the feed pressure is released the gears slip and the tool remains stationary. Another form of handpiece, which does not include the speed-reduction gearing, but has a multiple-plate friction clutch, operated by a trigger beneath the palm of the hand, is shown in the drawing, Fig. 11, from which its construction is obvious. It will be noticed that the working spindle is well supported by large ball bearings, while the end thrust is taken by a ball washer. Other types of handpieces are provided with a right-angle drive for getting into corners, and there is a little mechanically operated hammer for drilling small holes in rock and masonry.

THE CONSTRUCTIONAL ENGINEERING COMPANY, LTD.

There is a variety of foundry plant and appliances on the stand of the Constructional Engineering Company, Ltd., Titan Works, Charles Henry-street, Birmingham, together with several boilers, one of which is illustrated in Fig. 12.

The foundry plant includes the bottom section of a 4–5 ton per hour cupola, supported on solid drawn mild steel tubular columns, with independent adjustment to the tuyeres and an inspection door of equal area to the tuyeres incorporating a separate sight hole and poking hole. There is also a cupolette of 10 cwt. per hour capacity, a spark arrester, ladles, tumbling barrel, a sand driver, and so forth. But the most novel exhibit is a machine known as the Sand Wizard. It takes the place of sand-blasting apparatus in the fettling of castings, but uses far less power than is usually associated with such plant. It is, in fact, claimed that the same results can be obtained with this apparatus using only 3 h.p. as would be produced by a pneumatic sand-blasting plant requiring 30 h.p. This result is obtained by using centrifugal force to project the sand on to the castings to be cleaned. The sand, or steel shot abrasive, falls on to a rapidly rotating vane and is projected on to the articles to be cleaned. It falls into a lower chamber and is raised by means of an elevator. It is then passed through a sifter and back into the hopper from which it drops on to the centrifugal throwing device. The machine exhibited is capable of accommodating about 7 cwt. to 10 cwt. of castings at one time, and will clean them in from eight to fifteen minutes, according to the finish required.

The boiler, of which we give a sectional drawing in Fig. 12, is of the Wood's "Kwiksteam vertical type," and is intended for a working pressure of 100 lb. per square inch. It is claimed that it lives up to its name in being able to raise 80 lb. pressure from cold in thirty minutes, and has a normal capacity, when fired with coal, of 780 lb. per hour.

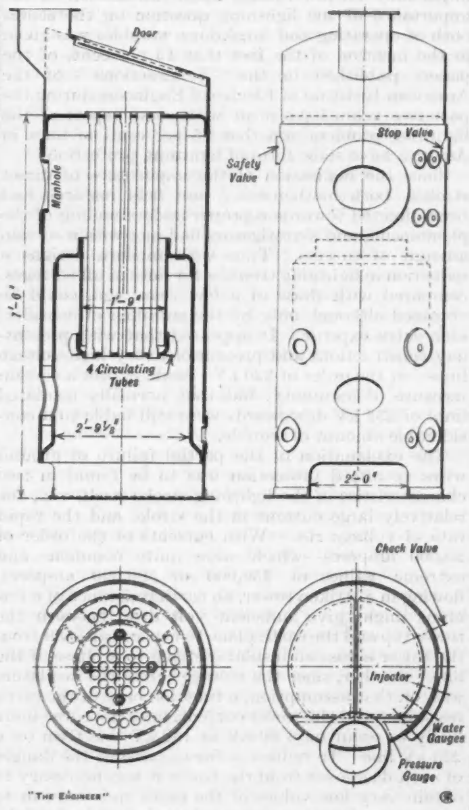

FIG. 12—"KWIKSTEAM" BOILER—CONSTRUCTIONAL ENGINEERING

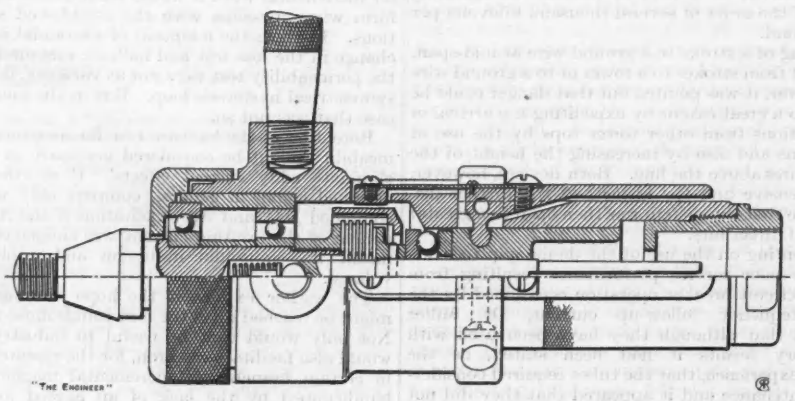

FIG. 11—HANDPIECE WITH MULTIPLATE FRICTION CLUTCH—FLEXTOL

As will be seen from the drawing, the peculiarity of the boiler lies in the design of the fire-box, from the crown of which there depends a water chamber, leaving an annular fire-space around. Fire tubes connect both the top of the annular space and the bottom of the depending chamber with the top tube plate of the boiler, while radial circulating tubes connect the bottom of the chamber with the main water space. In this way a vigorous circulation is promoted, and the boiler can be forced without fear of leaking joints. The boiler measures 3ft. 3in. in diameter by 7ft. 6in. in height, and is, of course, equipped with the usual set of fittings. There are, besides this boiler, a gas-fired boiler with automatic controls, some typical air receivers, and a range of dished and flanged ends, pressed steel manhole frames, &c.

THE SPERRY GYROSCOPE COMPANY, LTD.

Navigational equipment based on the gyroscopic compass forms the principal part of the exhibits of the Sperry Gyroscope Company, Ltd., of Brentford. In addition to examples of the company's gyroscopic compass, the exhibits falling under this heading include gyro-pilots for automatic steering, automatic course recorders, and several patterns of repeating devices. The company's other exhibits consist mainly of search-light equipment for use in ships or on the ground. The most notable exhibit in this class is a 60in. high-intensity searchlight fitted with a distant electrical control system.

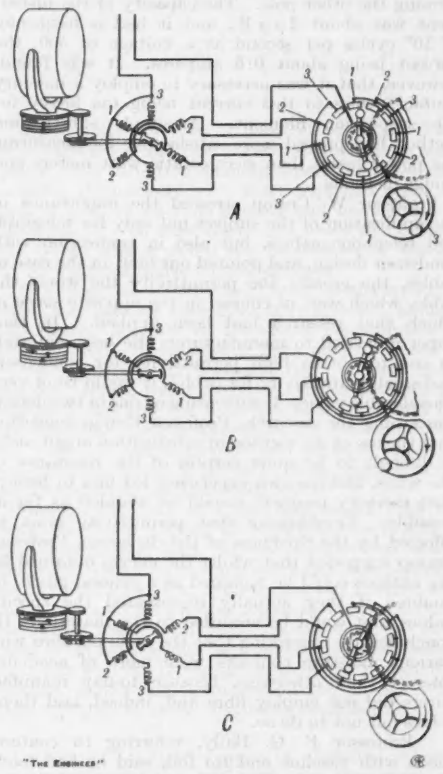

FIG. 13—DISTANT CONTROL SYSTEM FOR SEARCH-LIGHT—SPERRY

If an observer looks straight along the beam of a searchlight, his vision of the object illuminated is interfered with by virtue of the fact that he is looking at it through a cone of illuminated atmospheric particles stretching from his eye to the object. If he stands to one side of the beam the depth of illuminated space which his vision has to traverse will be reduced. To obtain entirely unobstructed vision he would theoretically have to stand at an infinite distance away from the beam. A distance of 50ft. is however sufficient to give him 90 per cent. of complete non-obstruction. If the observer is to govern the movement of the searchlight some form of distant control must be provided. A mechanical form of such control may be used but in most situations the existence of obstacles between the observer and the searchlight, the unevenness of the intervening ground or other cause renders an electrical form of control preferable especially if the distance of the observer from the searchlight is as great as 50ft.

Requirements to be fulfilled by an electrical system of control are: (*a*) it should allow the searchlight to be moved at any speed between three revolutions per minute and one revolution in three hours in order to permit the searchlight to follow the target at all ranges and at all angles of approach, (*b*) it should be silent in operation to avoid interference with sound locators as used in anti-aircraft defence, (*c*) the movements of the searchlight should be perfectly synchronised with the operator's movement of the controls, (*d*) if the movement of the searchlight is step-by-step and not continuous the steps should not be larger than ¼ deg.—*i.e.*, one-quarter the angular width of the beam—in order to avoid the possibility of the target being lost, (*e*) the training and elevating motors should have a high torque at all speeds in order to